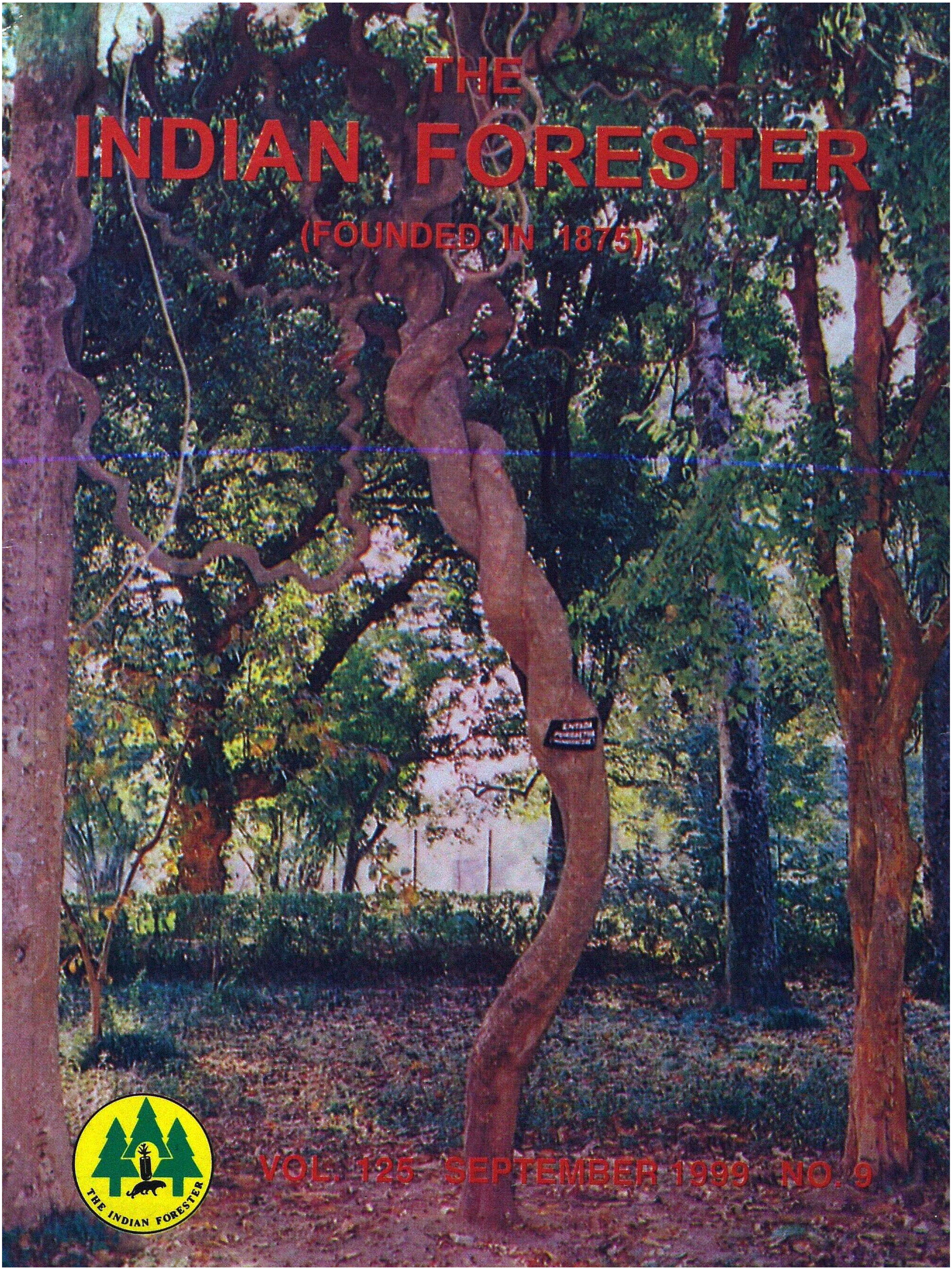

THE INDIAN FORESTER

(FOUNDED IN 1875)

VOL. 125 SEPTEMBER 1999 NO. 9

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ISSN 0019-4816

THE INDIAN FORESTER

Volume 125 **No. 9**

SEPTEMBER, 1999

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OCCURRENCE AND MANAGEMENT OF CANES IN WEST BENGAL

S.K. SARKAR*

Introduction

Canes are spiny climbers of subfamily Calamoideae of family Palmae. They are found either as a solitary plant or in cluster as in bamboos. Generally they are distributed in the Tropical Moist Deciduous and Semi-Evergreen Forests located in the Northern part of West Bengal, within 25°50' to 27°12'N Latitudes. There are over 600 species (within 14 genera) of canes all over the world with their maximum concentration in South East Asia. In India 46 spp. of 4 genera of canes are reported. In West Bengal 10 spp. belonging to 3 genera namely *Calamus*, *Daemonorops* and *Plectocomia* occur naturally in the moist pockets.

In West Bengal canes occur naturally within the agro-ecological zones of Sub-Himalayan Bhabar and Tarai. Rainfall occurs mainly from June to September (ranging from 2000 mm to 6250 mm, major part falls within the zone of 2500 mm to 3500 mm). The mean annual Relative Humidity is 83%. In hills summer is pleasant but in winter frost occurs. In foothills the temperature varies from 15°C to 38°C. Soil is generally fertile and deep, rich in humus, loam to clayey loam in texture.

Though canes require heavy soil and atmospheric moisture, they cannot tolerate waterlogging at all. The best areas of their occurrence are along stream banks in moist pockets. They require certain amount of overhead shade initially but later on they are light demanders. Though they are erect in the beginning, they need support as they grow.

With the exception of two high altitude canes, the other eight spp. appear in the wet mixed plain forest in the swampy pockets resulting in microclimate of climax vegetation with essentially edaphic climax.

The characteristics of all the 10 spp. are narrated below :

1. *Calamus erectus* : Growing erect. Only cane which is devoid of any climbing part. Recognised by the presence of the semicircular whorls of numerous thin spines on the stem as well as petioles. These are thick canes (7 cm dia) with big leaflets (70 cm x 3.77 cm). They occur naturally on either sides along Tista and Rangit rivers, upto 900m, mainly on the Eastern side on drier slopes of Tashiding, Bhalukhop, Sangser and Rongpo blocks of Kalimpong Division. This cane has no uses.

2. *Calamus flagellum* : Evergreen climber, common in M.P.F. (Mixed Plain Forest); Wet areas (Dalka Jhar and Singari Pahar forest) and L.H.F. (Lower Hill Forests) upto 900m. Dia 3 cm. Petiole and rachis deeply grooved. Leaflets green on both sides. Leaves resemble that of *C. erectus*. But the

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* Chief Conservator of Forests, Research and Development (West Bengal)

thorns of *C. erectus* are in horizontal semicircular whorls on rachis whereas those of *C. flagellum* are vertically arranged and alternately long and short. Leaves 1.5 to 2 m long but the middle leaflets are broader. Leaflets are not closely set but spaced 4 cm apart and are green on both sides. Upper side of rachis are deeply grooved. The leaf sheath is flagellate. Canes are soft.

3. *Calamus leptospadix* : Evergreen, climbing, common in valleys of L.H.F., specially in very damp places along rivers, where it forms a tangled thicket. The canes are thin and useless. Recognised easily by its narrow feathery foliage which is very pretty. Spadix stout with flagellum.

4. *Calamus guruba* : A tall slender climbing cane of Tarai, Duars and L.H.F. occurring upto 900m. Stem with sheath, measures 2 cm dia. Leaves are 1.5 to 2 m long having about 65 pairs of leaflets of maximum size 25 cm x 1.5 cm. Leaf sheath with a flagellum, which is covered with flattened spines and smaller crowded ones. Petiole and rachis with conical spines. Leaflets are very closely set unlike *Daemonorops jenkinsianus* and younger leaves have rustupuberous rachis. Flagellum originates from stem sheath.

This cane is in great demand for making basket, specially coal basket, ballast basket and also for furniture.

5. *Calamus tenuis* : Occurs strictly within the Tarai zone only where water table is high and therefore the area is generally swampy e.g. Cheko and Gadadhar Block of Damanpur Range of Buxa Tiger Reserve. Stem slender (dia 2 cm or less), scandent with typical light green appearance. Leaves are flagellate like *C. guruba*. Leaflets are thin and closely set, about 35 pairs in 1 m long leaf can be counted. Leaflets narrow gradually becoming shorter towards the apex of the leaf. Used for rattening and making furniture.

6. *Calamus acanthospathus* : Evergreen, strong climber. Found in L.H.F. and M.H.F. (150 m to 1800 m), fairly common in the Eastern part of Tista river in the higher part of L.H.F. In the Chel and Neora valley it forms dense thickets mixed with *Plectocomia*. Few occurr in Pumong and Him-Lingding Blocks. Rare now in West of Tista.

Leaflets are 45 cm x 5 cm ineqidistant, sometimes in alternate groups of 2 or 3, upto half of the rachis length. The remaining half is usually leafless. Older leaflets always split in the wind. Margins of the leaflets bear minute spines.

The climbing parts is cirrus i.e. extended rachis with 1-7 fid claws. Another very characteristic and distinguishing feature is the presence of very thin dense spines in the form of disjointed spirals on the leaf sheath. The stems are thick of the locality. Formerly employed for making bridges across streams. Very good for making baskets of all kinds and umbrella handles. Split canes are used for rattening chair seats.

7. (a) *Calamus latifolius* : Evergreen climber occurring upto 488m of M.H.F. of Tarai and Duars (Singari Pahar near Sevok Block of Kurseong Division) and in L.H.F. Canes thick, long strong but as they are not common are rarely used. Easily recognised by its broad leaflets, upto 8 cm, the number being very few. Stem green loose their lower leaves quickly. Leaf sheaths are not flagelliferous.

This cane is cirrate (like *D. jenkinsianus*), spines are flat and broad based occurring on leaf sheath. It is utilised best for rattaning chair seats and for making walking sticks.

(b) The variety *marmoratus* is also found and is also more slender than this type with smaller and fewer leaflets. Leaf sheath with dark green spots and are armed with whorls of broad based spines.

(c) *Calamus latifolius* var. *intermis* : A robust climbing cane of M.P.F. and L.H.F. Leaves 2.75-3,00 m long with 5-6 powerfully clawed flagellum. Occurrence is rare.

8. *Calamus viminalis* : This is reported to be found in Mahatpur area of Nadia District and part of Panighata and Bamonpokhri blocks of Kurseong Division. This is very rare.

9. *Plectocomia himalayana* : It is a thick, scandent rattan of M.H.F. and U.H.F. within 1200-2100 m. Very common. Stem 2.5 cm dia. Leaflets (50 cm x 4 cm) are clustered in groups of three leaflets alternated by groups of two leaflets. The margins of leaflets are provided with minute spiny teeth. Dies after flowering.

The cane is very rich in moisture content. Used for making rough basket (tea baskets), in fences, umbrella handles and other sports goods. It is widespread in Lingding block of Takda Range (Darjeeling Division) and in upper Babukhola Block (Kurseong Division). Found scattered in precipitous slopes of Lava Block (Kalimpong Division).

10. *Daemonorops jenkinsianus* : Found in M.P.F. and L.H.F. upto 900 m. Common locally. Stem very long, stout and scandent. Leaves are 3 m long, as many as 100 pairs of leaflets of size 60 cm x 2.5 cm, widely spaced (5 cm). The climbing organs (cirrus) having 3-5 very powerful fid claws. Old stem when cut produces milky exudation, hence the local name "Dudhia Bet". Used for making furniture frames, baskets and umbrella handles.

Management of Canes

In the past, cane areas were not subjected to any regular cultural operation and no attempt was made either to improve the quality or to increase the production. It was much in demand since long, particularly for the supply of plucking baskets required by large number of surrounding tea gardens. Cane used to be extracted on a cutting cycle of 3 years and no protection was given to the young and immature culm. Persistent demand and the continued scarcity made a vicious cycle and thus exploitation could not be controlled. To assure longer period of rest of the culm, the cutting cycle should be longer.

The policy of converting a forest with commercially important timber made the existence of canes delicate and it persisted and at times flourished only in the safer niches in the forests.

There is unfortunately rampant removal of immature canes illicitly from the natural forests and unless effective actions are taken to curb this, it will be difficult to preserve the cane and to get seeds for future propagation.

However in view of revised prescriptions in the working plans for regeneration of clearfelling areas (outside the natural forest), to preserve the cane brakes along the streams, the canes are likely to come up again.

Canes can be harvested upto 10% (mature only) at a cutting cycle of 4 years from clumps of age from 6 to 15 years. The older clumps yield more number of and better quality stem. A single clump may yield about a quintal of canes of 15 year's age. Care should be taken to harvest only mature stems which exhibit loosening of leaf sheath and exposure of lowest part of the stem. It should be harvested in dry season and dried appropriately (stacking them vertically to allow draining of moisture). Instead of pulling the canes from the branches of supporting trees, it should be untwined manually. If all these steps are followed properly and these are stored and processed properly the cane trade will be much benefited.

Moreover as Forest Conservation Act had disallowed clearfelling in natural forests, it is expected that cane bearing areas will remain undisturbed. And with this if extraction of immature culm can be prevented the cane may flourish again. However in artificially regenerated forests, it becomes very difficult to re-introduce cane though in selected areas artificial regeneration of canes can be resorted to.

Though cane occurs both in hills and plains Forest Divisions of West Bengal but from the various Working Plans of North Bengal, it is apparent that the exploitation was done, in some cases excessively, from the plains Forest Divisions, such as Jalpaiguri, Coochbehar, Buxa Divisions and in the plain areas of Kurseong Division. Accordingly the cutting cycle and felling rules were prescribed in the above Divisions only. In hill Divisions such as Kalimpong and Darjeeling, there is no mention of any such prescription for the management of canes, though cane exists there.

Canes occurred in good quantity in Moraghat and lower Tondu Ranges and in very limited quantity in Upper Tondu Range of Jalpaiguri Division. With the increase of clearfelling, regular thinning in plantations, fire incidence in high forests, the occurrence of cane had depleted.

Since 1964, as per C.F./Central's executive order, cane working is being done in a Range in a year, instead of working in part in several Ranges every year. As cutting cycle was 4 years and there are three cane bearing Ranges, there will be no production in every fourth year.

The sequence of working the cane coupe in 7th working plan of Jalpaiguri Forest Division (1970-71 to 1989-90) was as follows :- (The cutting cycle was 4 years)

Year of cutting	Range
1970-71 } 1974-75 } 1978-79 } 1982-83 } 1986-87 }	Upper Tondu
1971-72 } 1975-76 } 1979-80 } 1983-84 } 1987-88 }	Lower Tondu
1972-73 } 1976-77 } 1980-81 } 1984-85 } 1988-89 }	Moraghat
1973-74 } 1977-78 } 1981-82 } 1985-86 } 1989-90 }	No cutting

In addition to the cutting cycle mentioned above, canes in the clearfelling coupes of any Range should be worked one year ahead or during the year of main felling.

In Coochbehar Division (as per 2nd Working Plan - 1972-73 to 1981-82) distribution of cane was restricted in Barodabari, Mendabari and Bania Blocks of Chilapata Range and Salkumar Block of Jadapara Range. Though the supply was limited, the demand was high for basket making. Cutting cycle of 4 years were adopted. Cutting programme of cane of the Division is given in Appendix 'A'.

In Buxa Division (as per 7th Working Plan - 1975-76 to 1984-85), the cutting cycle was 5 years. It occurred in seven Ranges of this Division i.e. Nimati, Jainti, West Damanpur, East Damanpur, West Rajabhatkhawa, East Rajabhatkhawa, South Rydak in various Blocks. Annual area of felling varied from 1302 to 1704 ha. The details of cutting programme has been mentioned in Appendix 'B'.

In Kurseong Division (as per 5th Working Plan - 1969-70 to 1988-89), cane occurs in moist Sal forest of Bagdogra Range and along shaded jhoras of the foothill forests. It was also worked on a cutting cycle of 4 years. The cutting prescriptions of major cane bearing area are given in Appendix 'C'.

The average annual revenue obtained from canes in the 1960s was Rs. 20,580 and the average annual yield was 1,000 cartloads.

Canes were mostly disposed of at schedule of rates fixed for Northern Circle from time to time. During the period mentioned above, the schedule of rates of cane for Jalpaiguri Division was as follows :

Per Mazdoor load or bundle = Re. 1.00
Per cartload = Rs. 20.00

Though in 7th Working Plan of Buxa Forest Division (1975-76 to 1984-85) the schedule of rates was fixed as :

Per Mazdoor load or bundle = Re. 10.00
Per cartload = Rs. 200.00

One cartload = 25 Mazdoor loads

One bundle should not consists of more than 25 sticks of *Daemonorops jenkinsianus* and 100 sticks of *Calamus guruba*.

The following rules were prescribed to regulate the cutting of canes more or less in all the Divisions :

(i) Only mature stems will be exploited. The maturity of a cane is indicated by uniform straw colour all along its length.

(ii) Uprooting, cutting with rhizome or causing injuries to the rhizomes is not permitted.

(iii) The entire utilisable length of each stem shall also be exploited. Only a length of 1.2-1.5m from the top may be left.

(iv) In course utilisable of felling of trees in the cane area under any prescription, other than clearfelling, trees affording support to a number of cane stems should be left unfelled even though they be due for felling under the felling rules.

(v) Exploitation should proceed systematically from one end of a block irrespective of the mode of sale. The exploited stems should be stacked at a selected site before they are removed.

At present canes are not exploited from the forests, as in the past unscientific and excessive extraction than permitted, depleted the resources. So to give the rattans a chance to revive no cutting cycle has been prescribed in the cane bearing areas in recent Working Plans.

Artificial regeneration of Cane

Some trials of artificial regeneration were made with different techniques. The results of such trials are summarised below.

Older trials (1957-60) :

(a) Nursery raised seedlings with ball of earth planted under shade had high survival percentage (58-65%).

(b) Rhizome planted under shade is satisfactory. Survival percentage (44-94%).

(c) Offset planted under shade - moderate survival percentage (38-52%).

(d) Direct sowing failed totally.

Later trials (1962-1983) : Small plantations of *Daemonorops jenkinsianus* and *Calamus guruba* were raised in open or under a very light canopy but these failed, may be due to size of seedlings used (less than one year old) and eventual browsing.

Recent trials (1989 onwards) : Attempts were made to raise cane under older plantation (1967) in Damanpur Block with effect from 1989 upto 1991, using 2-3 years old seedlings raised in the nursery. One hectare was planted each year at 2 m x 2 m, within 1967 plantation at DPO-3. Survival is good though growth is slow.

It is prescribed that the seedlings are not to be planted too deeply and that the root collar is kept at ground level. After the seedlings have established, hoeing and mulching should be done once in 6 months.

Trials in Central Bengal : In Nadia District of Central Bengal, cane was underplanted in the low lying areas of older plantations raised in fifties, (Kisma cane plantation - Beat, Range & P.S. - Ranaghat; Mouza - Radhakantapur; J.L. No. 23; Plot No. 943; Area 22 ha) after thinning, during 1996 and again in 1998. The original crop comprised of *Tectona grandis, Terminalia arjuna, Cassia siamea, Acacia auriculiformis, Dalbergia sissoo* etc., the former two species being predominant. At present the average top height of old crop is about 25 m. Soil is sandy loam. As the seed source is from Mohatpur area of the district most possibly, it is *Calamus viminalis*.

Seeds were sown in June 1995. Germination per cent about 70. Viability of the seeds were nearly one year. Original seeds were soaked and baked alternately for 15 days (as the seed coat is very hard like Teak fruit) and then sown broadcast in the nursery beds. As soon as germination starts these are pricked out in polythene tube (5 cm x 15 cm) and kept in bed for one year and watered when needed. In last week of June 96, when the monsoon set in, these were underplanted in the older plantation in pits of 60 cm x 40 cm x 30 cm size at 2.5 m x 2.5 m apart. Weeding and cleaning was done in July 96. Survival per cent is good. Viability of the seed is about 1 year as the seeds are found to germinate gradually for a prolonged period even upto 1 year.

In Hizuli protected forest of Ranaghat Range adjacent to Range Office, a 5 ha area was underplanted each year from 1989 to 1991 in low lying areas 1 m x 1 m apart. Canes survived and took growth in patches. Overhead was *Dalbergia sissoo, Gmelina arborea, Lagerstroemia parviflora, Terminalia arjuna, Albizia lebbek, A. auriculiformis*. Both *Calamus tenuis* and *C. viminalis* were planted. Both are promising, particularly in shady areas having nearby support trees. At present average culms per ha are about 400 which is capable of yielding 2000 stem. Average height is about 2.5 m, but in suitable areas and near the support is more than 5 m. In 1996 plantation the average height is about a metre.

Trials in Coastal areas : Artificial regeneration of *Daemonorops jenkinsianus* was tried in Digha coast in front of Digha Forest Rest House. Ten seedlings were brought from Rajabhatkhawa during 1988, though the origin of the seed were from Taipu Block of Bagdogra Range, Kurseong Division. First of all the seedlings were kept in laboratory condition treating with Gibberellic Acid 100, 200, 300 ppm. The treatment with G.A. 300 ppm was found best though when planted out in the field, treatment with G.A. 200 ppm was found best. Planted out in the field on 04.07.1990 under the shade of *Acacia auriculiformis*. Out of ten seedlings planted only six survived in the comparative higher ground. Others died due to water logging. The remaining plants established, though get damaged periodically in strong wind.

Pre-treatments of seeds : To ensure a good germination the outer scaly cover should be removed by crushing the fruit with hands or by pounding them gently in a mortar with a wooden mallet as done for dehusking paddy. To remove the inner fleshy layer the seeds should be soaked in water for about 2 days to induce fermentation of the fleshy portion. Fleshy part of the seeds are removed by rubbing with hands and the clean seeds are collected which had settled at the bottom of the vessel. These seeds can be stored for a week but care should be taken to keep the seeds moist.

Treated seeds should be kept in moist saw dust in polythene bag for about two weeks till the seeds start to germinate.

Conclusion

It appears from the above discussion that cane had a glorious past in North Bengal forests as a valuable and important non timber forest produce. In fact based on this resources, lot of cottage industries grew up in Damanpur, Lataguri and Siliguri for making furniture and household materials. But due to unscientific management and excessive exploitation coupled with conversion of natural forests depleted the resources.

Recent ban on extraction of cane and conversion of natural forests will provide the much needed rest for cane to resuscitate. Simultaneously systematic regeneration of cane artificially in suitable habitat will help rehabilitation of the same of its lost ground.

Appendix - 'A'

Cutting cycle of Cane in Coochbehar Forest Division

1972-73 }		1973-74 }					
1976-77 }	Bania	1977-78 }	Borodabari	1974-75 }	Mendabari	1975-76 }	Salkumar
1980-81 }	Block	1981-82 }	Block	1978-79 }	Block	1979-80 }	Block

Appendix 'B'

Cutting cycle of Cane in Buxa Forest Division

Year	Range	Blk. & Compartt.		Area (ha)	Total	Grand Total
1	2	3	4	5	6	7
1975-76 & 1980-81	Nimati	Nimati	-2	30		
		Poro	-1	350	380	
	Jainti	Panbari	-1	124		
		"	-2	100		
		"	-3	52		
		"	-6	330	606	
	W. Rvk	S. Rvk	-1	50	50	
	W. Dpo	Dpo	-1	190	190	
	S. Ryd			95	95	1321 ha
1976-77 & 1981-82	Nimati	Nimati	-4	10		
		"	-5	16		
		Poro	-2	177	203	
	Jainti	Panbari	-7	266		
		"	-8	174	430	
	W.Rvk	S. Rvk	-8	169	169	
	N. Dpo	Dpo	-1	224	224	
	E. Dpo	Checko	-1	4		
		"	-2	72	76	
	S. Ryd	S. Ryd	-2		337	1439 ha
1977-78 & 1982-83	Jainti	Panbari	-9	337	337	
	W. Rvk	S. Rvk	-9	425	425	
	W. Dpo	Poro	-3	264		
		"	-4	61	325	
	E. Dpo	Checko	-3	141		
		"	-5	7	148	
	S. Ryd	S. Ryd	-3	469	469	1704 ha
1978-79 & 1983-84	Nimati	Nimati	-6	19	19	
	E. Rvk	S. Rvk	-10	57		

(Contd...)

1	2	3	4	5	6	7
		S. Rvk	-11	192		
		”	-12	179		
		”	-13	261	289	
	W. Dpo	Dpo	-5	348	348	
	E. Dpo	Checko	-6	80	80	
	Ryd	S. Ryd	-4	276	276	1393 ha
1979-80	Nimati	Nimati	-7	16		
&		Poro	-6	70		
1984-85		”	-11	60	146	
	Jayanti	Panbari	-10	131	131	
	W. Rvk	S. Rvk	-16	335	335	
	E. Rvk	”	-14	200	200	
	W. Dpo	Poro	-8	10	10	
	E. Dpo	Checko	-7	250	250	
	Ryd	S. Ryd	-6	230	230	1302 ha

Dpo = Damanpur. Rdk = Rydak. Rvk = Rajabhatkhawa

Appendix ‘C’

Cutting cycle of Cane in Kurseong Forest Division

Year of Working	Range	Blocks
1969-70		
73-74		
77-78		
81-82		
85-86	Bagdogra	Dalka, Taipu & Central
1970-71	Sukna	Gulma Valley, Choklong & Jogighora
74-75		
78-79	Sevoke	Chawa, Andera, Gola, Letpanchar & Kuhi
82-83		
86-87		
1971-72	Bagdogra	Bangdubi, Bagdogra, & Rishabari
75-76		
79-80		
83-84		
87-88		
1972-73	Bagdogra	Malta & Lalfa
76-77		
80-81		
85-86		
88-89		

SUMMARY

In West Bengal canes occur naturally within the agro-climatic zones of Sub-Himalayan Bhabar and Tarai. With the exception of two high altitude canes, other eight species appear in wet mixed plain forests in the swampy pockets. In the recent past, canes were extracted on a cutting cycle of 3 to 5 years. But over-exploitation surreptitiously, extraction of immature plants and clearfelling of natural forests depleted these valuable resources, which were much in demand in local rattan industries. At present, discontinuing clearfelling in natural forests under the provision of Forest Conservation Act, ban on extraction of cane in Working Plan prescription and resorting to artificial regeneration in suitable habitat help rehabilitation of cane in this State.

पश्चिम बंगाल में बेंत की प्राप्ति और उसका प्रबन्ध

एस०के० सरकार

सारांश

पश्चिम बंगाल में बेंत वहाँ के उपहिमालय भाभर और तराई प्रदेशों के कृषि – जलवायु क्षेत्रों में स्वभावतः होती पाई जाती है। अधिक ऊंचाइयों पर होने वाली दो जातियों को छोड़ बेंत की अन्य आठों जातियाँ यहाँ के दलदली टुकड़ों में आर्द्र मिश्र मैदानी वनों में मिल जाती हैं । विगत भूतकाल में बेंत की निकासी 3 से 5 वर्षों के कटान चक्र पर की जाती रही है । परन्तु चोरीछिपे अतिसमुपयोजन, अप्रौढ़ पादपों का निष्कर्षण और प्राकृतिक वनों का निस्शेष पातन किया जाने से यह मूल्यवान संसाधन, जिसकी स्थानीय बेंत उद्योग में बहुत मांग है, लगभग क्षत्म हो गया है । इस समय वन संरक्षण अधिनियम के प्रावधानों के अधीन प्राकृतिक वनों का निस्शेष पातन बंद किया जाने, कार्य योजना आदेशों में बेंत की निकासी पर प्रतिबन्ध लगा दिया जाने और उपयुक्त प्राकृतावासों में इसका कृत्रिम पुनर्जनन कराया जाने लगने से इस राज्य में बेंत का पुर्नस्थापन करानें में बहुत सहायता मिल रही है ।

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COMPARATIVE STUDY OF THE GROWTH AND YIELD OF SOME MULTIPURPOSE TREES IN A TROPICAL RAIN FOREST OF SOUTH -WESTERN NIGERIA

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Introduction

One of the most challenging problems facing Sub-Saharan Africa is the production of food and forest products to sustain the burgeoning population. Deforestation, erosion with attendant declining soil fertility problems and land degradation have resulted from efforts to solve these problems.

The fragile soils are inherently relatively infertile, predominantly composed of the kaolinitic clays with low water and nutrient retention capacities. Their fertility thus largely depends on their organic matter content, but this breaks down rapidly under cultivation. Consequently, the crucial soil management factor which appears to be organic matter maintenance, seems to be difficult to sustain without a tree phase.

Agroforestry has been recently conceptualized as the beneficial alternative farming system to sustainable land-use in the region. The role of Multipurpose Trees and Shrubs (MPTS) as an integral part of such a system has been stressed (von Carlowitz, 1987; Palmberg, 1989; Baumer, 1990; Okali, 1992). These researchers have also reported the relative dearth of information on tree characteristics compared to other components of the system such as grasses, livestock and arable crops especially on the growth characteristics. More recently, studies have been reported on the early growth characteristics of some exotic species (Nair *et al.*, 1984; Bashir *et al.*, 1989). Little has been done on the wood yields for mature MPTS for valuable products such as poles, sawlogs and fuelwood especially with respect to indigenous species.

This paper reports the growth and yield analyses of some indigenous and exotic MPTS of a 14 year old mixed stand (arboretum) located at the International Institute of Tropical Agriculture (IITA) Ibadan, Western Nigeria. The study include merchantable standing wood yields of 9 selected MPTS. Wood yields of the species are related to an easily controllable variable - crown diameters with their implications under multiple land-use practices.

Material and Methods

Study Site : In 1979, an MPTS Agroforestry arboretum (1.50 ha) was established in IITA, Ibadan (7°29'N, 3°45'E) in the sub-humid tropical climatic zone. Average annual rain for the area is about 1200-1300mm and bimodally distributed with a marked dry season from November-March.

The average minimum and maximum temperatures are 22°C and 32°C respectively. Soils are well drained and were formed from rocks of pre-Cambian basement complex especially of granite, gneisses and Schist (Aweto, 1987) which tend to be more fertile than those over sedimentary formations. It is a good representative of a region with high base status soil of the tropics.

The arboretum was divided into rectangular plots of size 10m x 16m (0.016 ha). Tree species and shrubs were then planted with each species allocated per plot at an equal spacing of 2m x 4m (30 seedlings per plot). Distance between adjacent plots is relatively constant at 3m (Figure 1). The stand did not receive any silvicultural treatment since its establishment. The arboretum thus represented a mixed even-aged stand.

Data Collection : A reconnaissance survey of the arboretum was carried out in January, 1993. All the species and shrubs in the stand were assessed for survival.

Nine tree species were selected which include *Cordia alliodora, Pterocarpus soyauxii, Treculia africana, Cassia siamea, Blighia sapida, Pentaclethra macrophylla, Dialium guineense, Gmelina arborea*, and *Vitellaria paradoxa*. Selection was based on some criteria like high survival rate (60% and above), ecological zone of the provenance and trees with well-formed stems with clear easily measurable boles.

In each plot of the selected species, the diameter at breast height (1.3m above ground, dbh) of all the trees were measured with a girth tape. Trees that forked into two or three were treated as 2 or 3 stems respectively. For each tree, the merchantable and total heights were measured with an Haga altimeter. Merchantable height of the tree represented the distance between the ground level and the terminal point of the last usable portion of the tree. The total height was that distance measured from the ground level to the tip of the tree. Crown diameter was estimated for each tree by visually projecting the edges of the crown and then measuring the ground distance between the projected edges. The average distance of the longest diameter and the distance at right angle to it was used as a measure of crown diameter.

Diameter data sets for each (tree) species were then grouped into diameter classes with the interval of 5cm. Diameters were then taken at various Hohenaldth's (0.1, 0.3, 0.5, 0.7, 0.9) of the merchantable height of the mean tree in each diameter class for the purpose of form factor computation.

Basal area Calculation : The basal area of each tree in the plot was computed as follows :

$$(BA)_i = \pi D_i^2/4$$

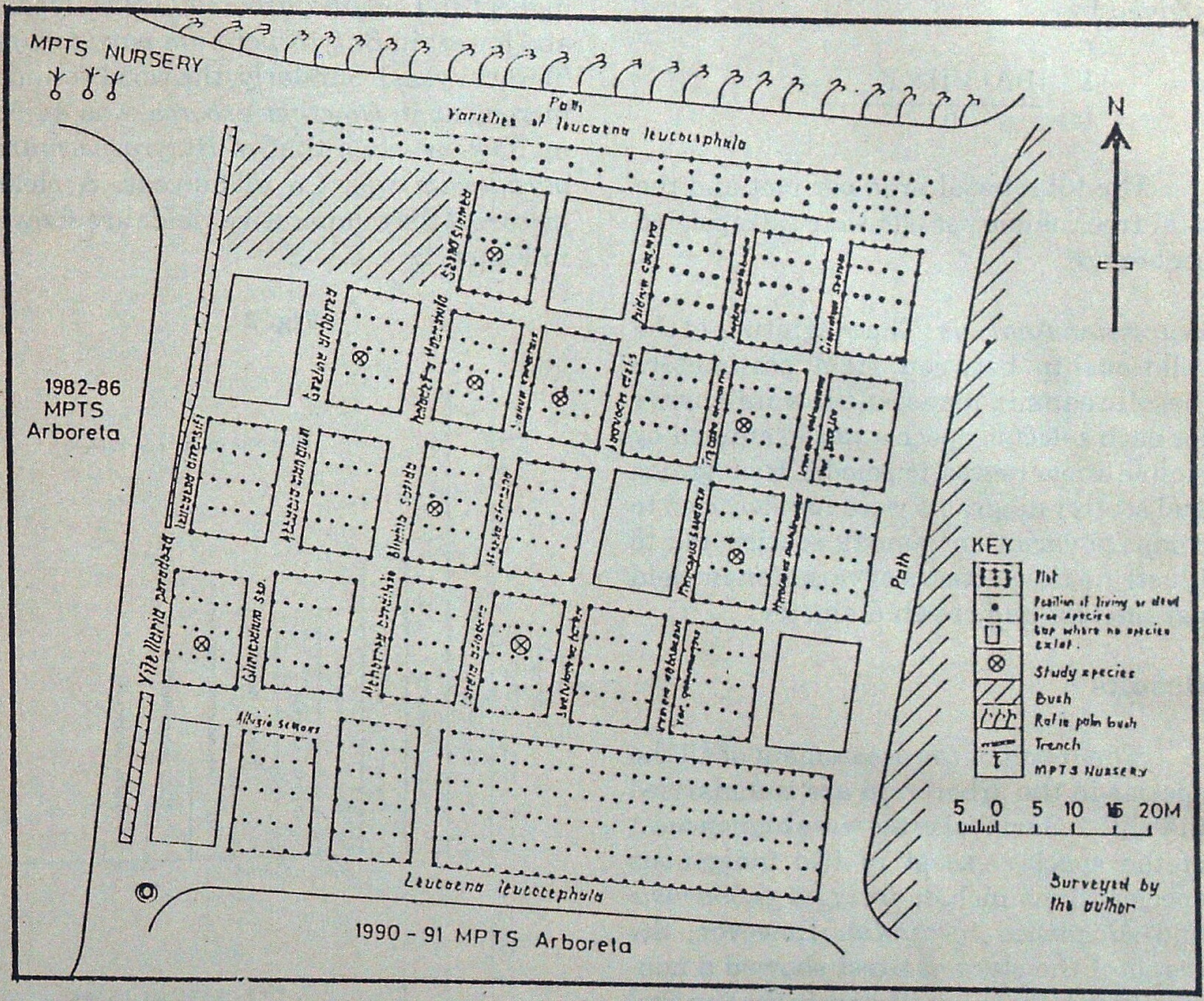
The total basal area per plot was given as :

$$\sum_{i=1}^{n} (BA)_i = \sum_{i=1}^{n} \pi D_i^2/4$$

The mean basal area per tree per plot (BA)

$$\overline{(BA)} = \sum_{i=1}^{n} \pi D_i^2/4/n$$

Fig. 1


MPTS NURSERY
Path
Varieties of Leucaena leucocephala
N
1982-86 MPTS Arboreta
Albizia saman
Path
KEY
Plot
Position of living or dead tree species
Gap where no species exist.
Study species
Bush
Rafia palm bush
Trench
MPTS NURSERY
5 0 5 10 15 20M
Surveyed by the author
Leucaena leucocephala
1990 - 91 MPTS Arboreta

Layout of 1979 MPTS Agroforestry Arboretum (IITA, Ibadan, Nigeria)

where, Di = Diameter at breast height of tree i

n = number of stems in plot i

Volume estimation : The volume of each tree in each plot was calculated as :

$$V = (BA) \times H \times F$$

where

$$F = 0.2\left[1+\left(\frac{d_{0.3}}{d_{0.1}}\right)^2+\left(\frac{d_{0.50}}{d_{0.1}}\right)^2+\left(\frac{d_{0.7}}{d_{0.1}}\right)^2+\left(\frac{d_{0.9}}{d_{0.1}}\right)^2\right]$$

(Hohenald's formula, Loetsch *et al.*, 1973; Cailliez, 1980).

do.x = Diameter at point x along the merchantable height of the mean tree in each diameter class (X = 1, 3, 5, 7, 9).

$$\overline{F} = \sum_{i=1}^{k} F_i/k \quad = \text{Mean form factor}$$

K = number of diameter classes.

H = Merchantable height

The mean volume per tree per plot (V) is given by

$$V = \sum_{i=1}^{n} \frac{(BA)_i \times H \times F}{n}$$

The total basal area per plot and the total tree volume per plot were extrapolated per hectare.

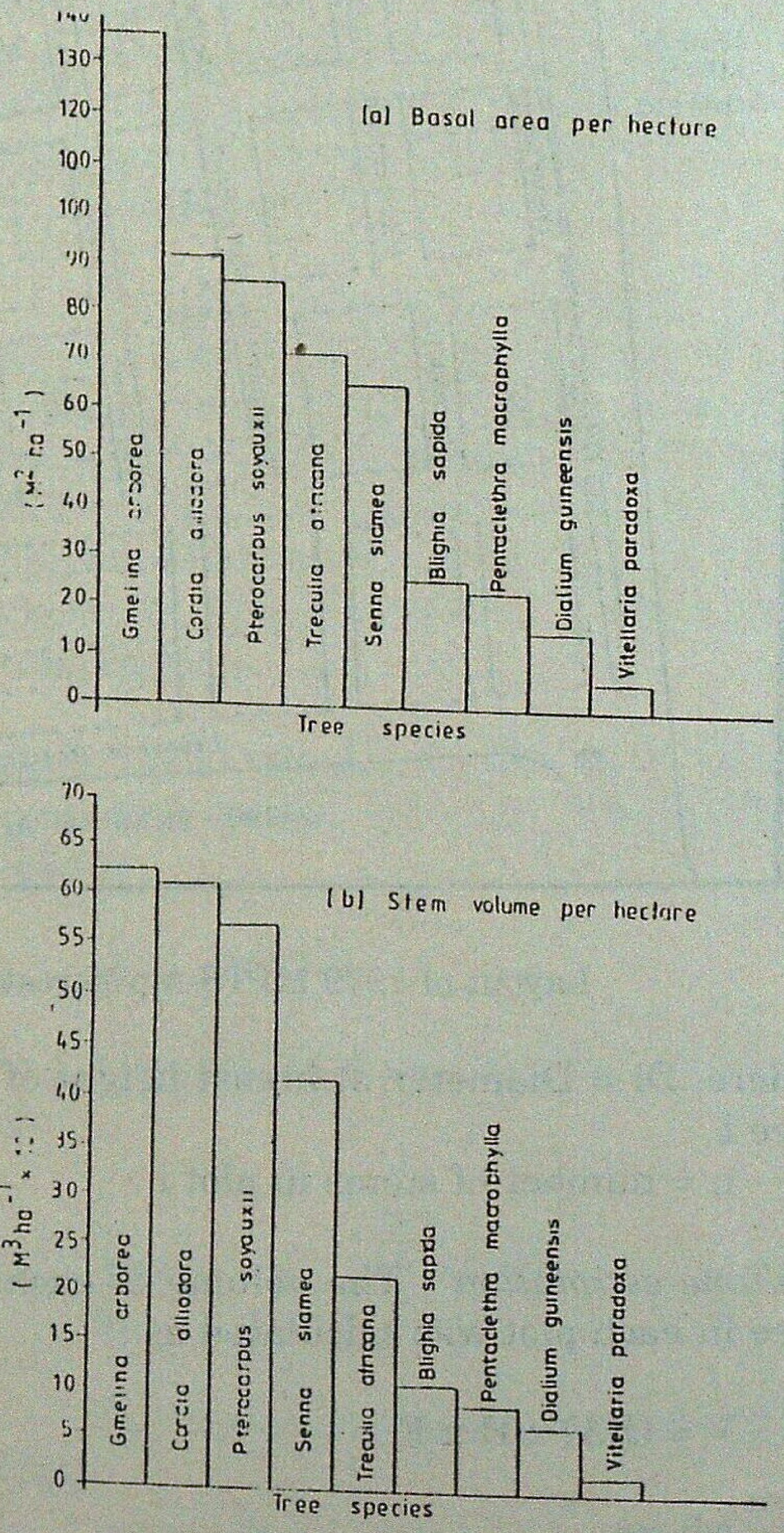
Regression Analysis : The magnitude of the relationship between yield parameters (basal area and volume) and crown diameter for each selected species was examined by simple linear regression model. Histograms and scatter diagrams were further used to compare variations among species and to illustrate the patterns of variation in yield parameters and crown diameter.

Results

The result of the assessment of all the species in the arboretum are summarised in Table 1. Survival rates were high in most of the species except in two indigenous species which include *Irvingia gabonensis* and *Alchornea cordifolia*. However, the result of the student t-test showed a non-significant ($P>0.05$) variation in the survival rates between the exotic and the indigenous species of trees and shrubs in the arboretum.

Growth and Yield Parameters : The tree growth parameters which include diameter at breast height, merchantable height, total height and crown diameter are summarized in Tables 2 (a, b). Also included in the table are tree basal area and wood volume. The exotic species like *Gmelina arborea* and *Cordia alliordora* were superior in terms of growth and yield to most of the indigenous species like *Blighia sapida, Dialium guineense* and *Treculia africana*. The Mean Annual Increment (MAI) in diameter was highest in *Gmelina arborea* (1.9 cm/year) and lowest in *Butyrospermum paradoxum* (0.61 cm/year). Similarly, the wood volume increment in *Gmelina arborea* was 44.98 m³/ha/year while that of *Butyrospermum paradoxum* was 1.5 m³/ha/year. A clear picture of the comparative yields are shown in Figure 2.

Fig. 2



Comparative yields in terms of Basal area/ha and stem volume/ha of 9 MPTS at IITA, Ibadan, Nigeria

Table 1

Classification of species in the arboretum

Species	Family	Provenance	Ecological zone	Survival (%)
Afzelia africana	Leguminosae (Caesalpiniaceae)	Indigenous	Forest	96.7
Alchornea cordifolia	Euphorbiaceae	Indigenous	Forest	13.3
Blighia sapida	Sapindaceae	Indigenous	Forest	96.7*
Butyrospermum paradoxum	Sapotaceae	Indigenous	Savanna	60.0*
Cassia siamea	Leguminosae (Caesalpiniaceae)	Exotic	Sub humid zone of Southern India	86.7*
Cordia alliodora	Boraginaceae	Exotic	Tropical America	100*
Dacryoides edulis	Bossuraceae	Indigenous	Forest	36.7
Dactyledenia barteri	Chrysobalanceae	Indigenous	Forest	93.3
Dialium guineense	Leguminosae (Caesalpiniaceae)	Indigenous	Forest	90.0*
Gliricidia sepum	Leguminosae (Pappillionaceae)	Exotic	Tropical America	93.3
Gmelina arborea	Verbenaceae	Exotic	Tropical Asia	100*
Irvingia gabonensis	Irvingiaceae	Indigenous	Forest	30.0
I. gabonensis var. *gabonensis*	Irvingiaceae	Indigenous	Forest	16.7
Leucaena diversifolia	Leguminosae (Mimosaceae)	Exotic	Tropical America and West Indies	60.0
Leucaena leucocephala	Leguminosae (Mimosaceae)	Exotic	Tropical America and West Indies	100
Parkia biglobosa	Leguminosae (Mimosaceae)	Indigenous	Savanna	53.3
Pentaclethra macrophylla	Leguminosae (Mimosaceae)	Indigenous	Forest	86.7*
Psidium guajava	Myrtaceae	Exotic	Tropical America	80.0
Pterocarpus santalinoides	Leguminosae (Pappillionaceae)	Indigenous	Savanna	100
Pterocarpus soyauxii	Leguminosae (Pappillionaceae)	Indigenous	Forest	93.3*
Samanea saman	Leguminosae	Exotic	South America	96.7
Treculia africana	Moraceae	Indigenous	Forest	100*

* denotes selected tree species for study; () brackets denote sub families of Leguminous species

Table 2(a)

Comparative Growth and Yield data for 9 multipurpose trees/species

Species	Growth parameters			Yield parameters			
	Dbh (cm)	M.ht (m)	Total ht (m)	Crown diameter (m)	Form factor	Basal Area (m^2)	Volume (m^3)
Blighia sapida	13.87	7.88	12.70	4.46	0.466	0.016	0.068
Butyrospermum paradoxum	8.48	3.12	6.65	3.01	0.936	0.006	0.019
Cassia siamea	18.25	8.88	16.63	6.08	0.660	0.028	0.176
Cordia alliodora	23.74	15.17	24.26	5.60	0.425	0.047	0.317
Dialium guineense	10.38	4.31	9.33	4.42	0.844	0.009	0.036
Gmelina arborea	26.96	12.61	20.17	6.16	0.350	0.064	0.295
Pentaclethra macrophylla	10.73	3.76	8.94	3.70	0.774	0.011	0.038
Pterocarpus soyauxii	17.93	8.95	15.53	4.37	0.507	0.033	0.211
Treculia africana	16.70	8.69	15.10	4.58	0.316	0.024	0.073

Table 2(b)

Comparative Wood Yields in terms of number of stems, Basal area, and volume per hectare; and Mean Annual increment of 9 Multipurpose tress/species

Species	Yield			Mean Annual Increment			
	No of stems per ha	Basal Area/ha (m^2/ha)	Volume per ha (m^3/ha)	Total height (m/yr)	Dbh (cm/yr)	Basal Area (m^2/ha/yr)	Volume (m^3/ha/yr)
Blighia sapida	1687	27.63	114.00	0.91	0.99	1.97	8.14
Butyrospermum paradoxum	1125	6.88	21.38	0.48	0.61	0.49	1.53
Seppa siamea	2375	66.25	418.38	1.19	1.31	4.75	28.88
Cordia alliodora	1937	91.31	615.06	1.73	1.70	6.50	43.93
Dialium guineense	2000	18.50	71.00	0.67	0.74	1.32	5.07
Gmelina arborea	2125	136.56	626.94	1.44	1.93	9.75	44.78
Pentaclethra macrophylla	2375	25.44	90.25	0.64	0.77	1.82	6.45
Pterocarpus soyauxii	2687	87.44	566.00	1.11	1.28	6.25	40.43
Treculia africana	3000	73.19	218.75	1.08	1.19	5.23	15.63

There were significant differences in the growth parameters even within trees of the same age and of the same species, planted on the same site and spacing. The better performances of the exotic species over the indigenous ones was similarly reported by Bashir *et al.* (1989) in their study of the growth rates of 29 MPTS in a 6-year old arboretum in the subhumid zone of Machakos, Kenya. Evans (1982) explained that exotic species, planted away from its natural habitat were often free from diseases and pests for the first rotation at least since insects and fungal pathogens in the recipient region may not find the 'alien' species a suitable host. While exotic species might have initial freedom from organic damage in the new habitat, but does not last indefinitely.

Yield Parameters and Crown Diameter : Strong linear relationships exist between yield parameters (basal area and volume) and crown diameter in all the 9 selected species. Simple linear regression equations for each of the selected species and the graphs of yield parameters against crown diameter are illustrated in Figure 3 (a, b, c). The range of values for the correlation coefficients basal area/crown diameter lied between ($0.510 < r < 0.88$) while the volume/crown diameter correlation coefficients ranged between ($0.40 < r < 0.76$). These relationships are hardly surprising since the tree leaves provide the photosynthate from which the wood is built. The larger the tree crown, the bigger the amount of wood built (Dawkins, 1963).

MPTS in the Sustainable use of Nigerian Tropical Moist Forest lands : Deforestation and land degradation in the Nigerian moist forests resulted from the inability to manage crop and forest production on a sustained basis. Wood is needed to meet rising domestic demands, land is needed for expanding agriculture and housing. In fact, Nigeria has been a net importer of industrial wood since 1975 and actually banned wood export in 1976 (Okali, 1992).

It is now obvious that Nigeria can no longer meet her wood requirements solely from the natural forests. The concept of Agroforestry thus provides a unique opportunity for the development of new systems that could enhance both food and wood production capabilities.

There are some ecologically sound and productive farming systems that have been successful in the Nigerian tropical moist forests. These include plantation agriculture for cocoa, coffee, rubber and oil palm. These tree crops are grown for cash only. But as the farmer is drawn closer and closer into a cash economy, his objectives are changing increasingly to emphasize the production of surpluses for cash at the neglect of food production (Hartmanns, 1984).

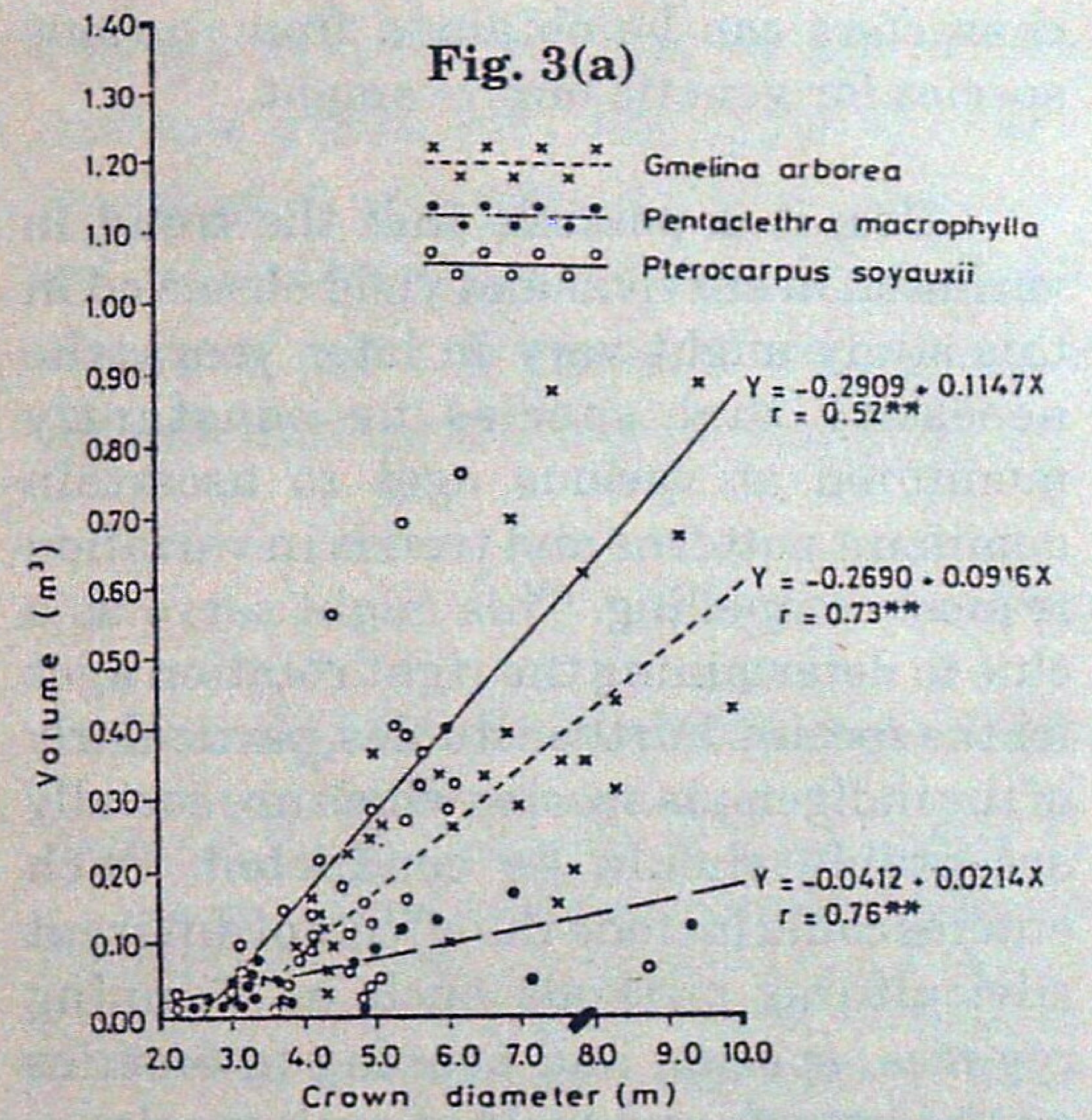
A thorough knowledge of some MPTS could provide a guide to the benefits of growing such tree crops with arable crops. For example, vegetation management through the manipulations of the canopies of these MPTs have the potentials to :

(i) Provide browse for livestock and fuelwood for energy through the pruning of the MPTS.

(ii) Reduce farming in-puts for resource-poor farmers by improving soil fertility thus minimizing mineral fertilizer requirements.

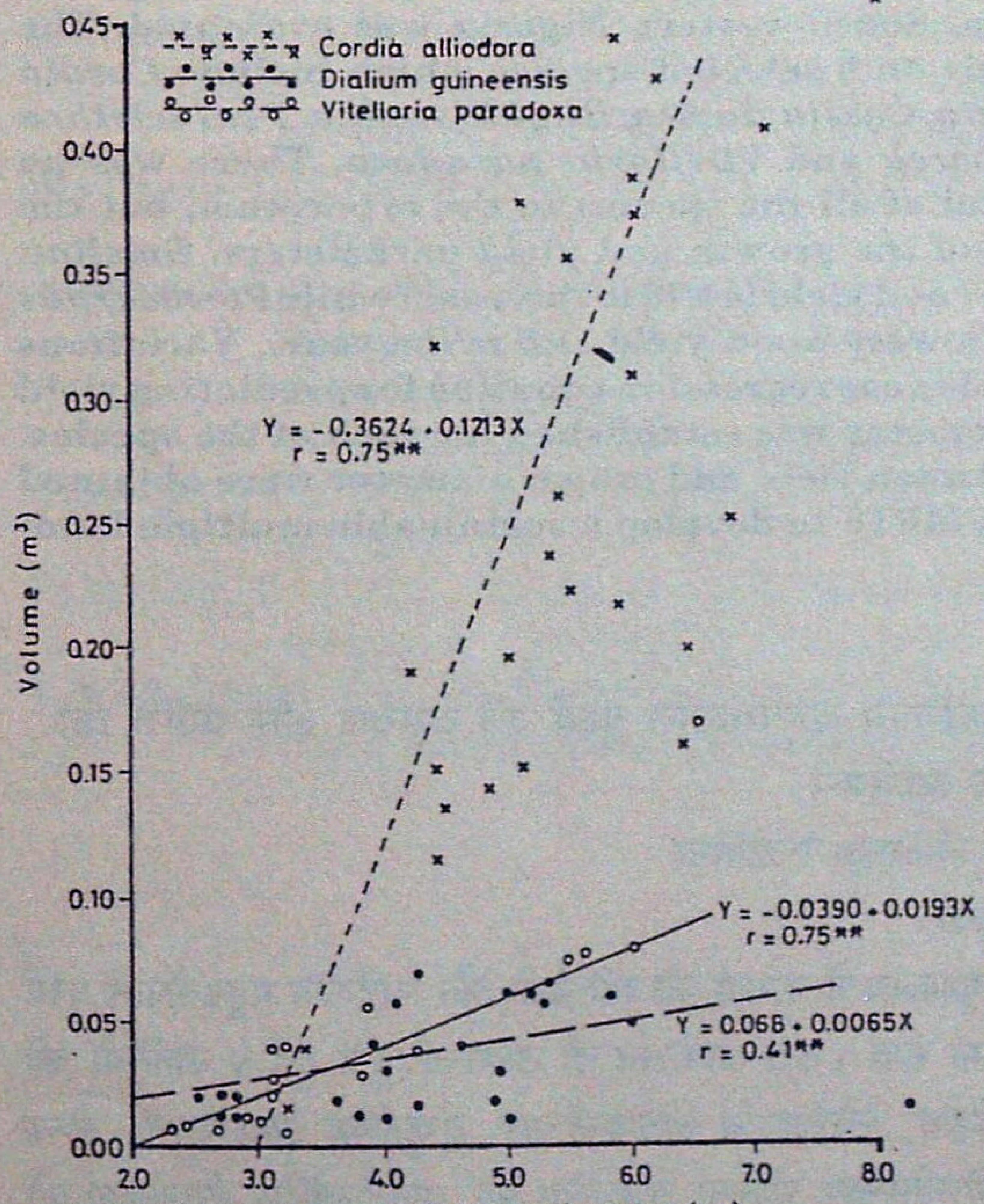
(iii) Stabilize soil and reduce erosion.

Fig. 3(a)



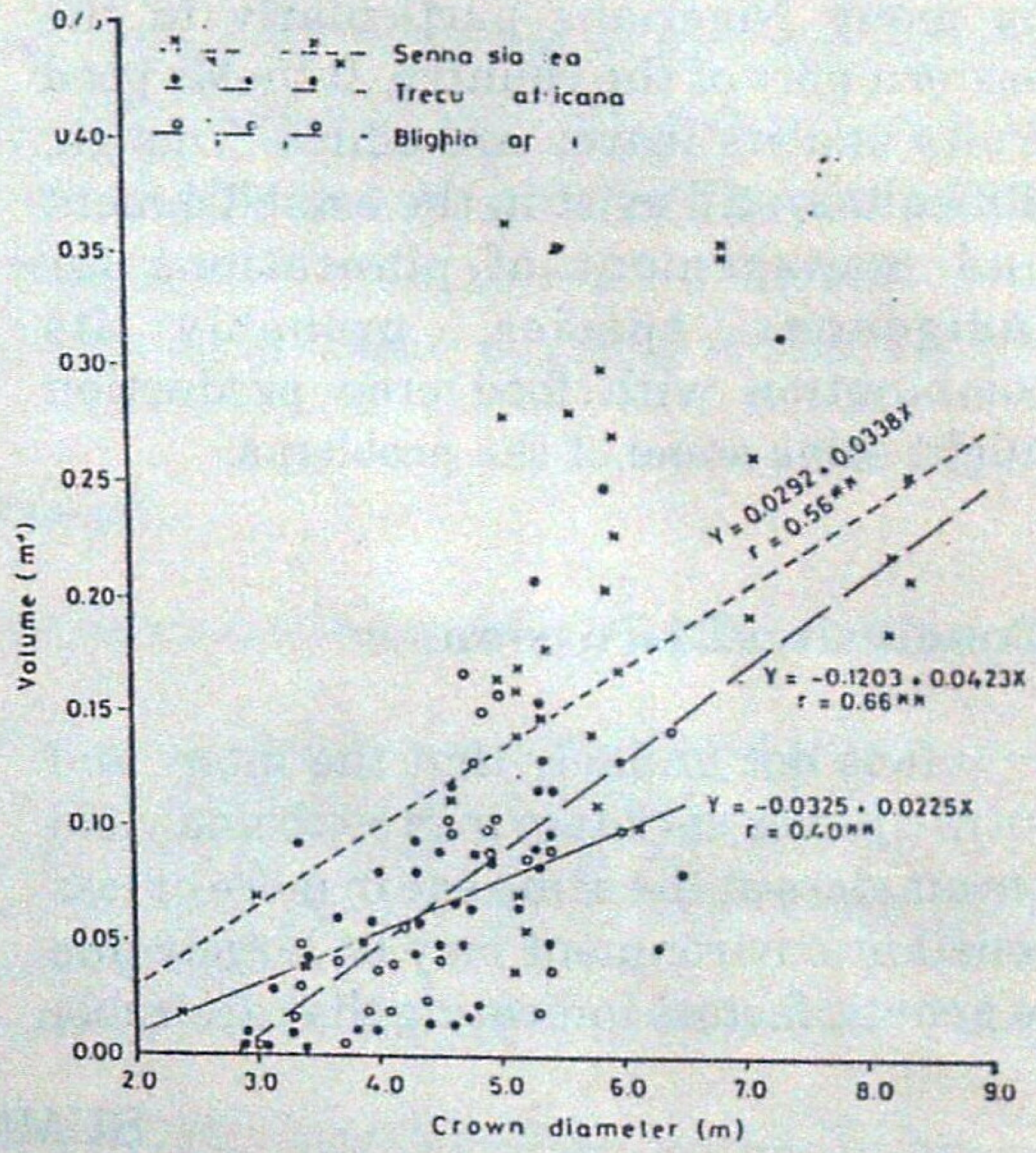
Scatter diagramme of Volume against Crown Diameter for *Gmelina*, *Pentaclethera* and *Pterocarpus*.

Fig. 3(b)



Scatter diagramme of Volume against Crown Diameter for *Cordia*, *Dialium* and *Vitellaria*

Fig. 3(c)



Scatter diagramme of Volume against Crown Diameter for *Cassia*, *Treculia* and *Blighia*.

Plantation production of wood is now the main emphasis of forest management in Nigeria (Nwoboshi, 1982; 1987). In general, exploited natural forest is replaced with planted forest containing one or a controlled mixture of two species notably the fast growing exotic species of Teak (*Tectona grandis*) and Gmelina (*Gmelina arborea* Roxb). Plantation development can further be enhanced by the use of more indigenous species in the MPTS group.

These species could be selected to meet different objectives. For example indigenous species like *Pterocarpus soyauxii* is a suitable candidate for wood production on account of its higher stem wood production. It is also suitable for watershed management as well as erosion control in view of its large crown size. Similarly, *Irvingia gabonensis* could be selected because of its socio-economic acceptability by many Nigerians particularly in the eastern part of the country. It yields good fruits and its leaves are edible. Though, difficulties still exist in the establishment and management of plantations for indigenous species, probably its combination with food crop production might solve some of the problems.

Conclusion/Discussion

It is not unlikely that the inter- and intra-species variation in growth and yield parameters at the same age in more or less constant environment may be largely due to genetic factors indicating that desirable characters can be obtained from various species for genetic improvement.

Also, it is possible that the trend in variation in survival and yield observed in this study might vary in later years, the necessity that species be constantly monitored at various ages to ascertain dominant patterns and trends in variation is most compelling. This might serve as a clue to determining the right rotation ages for the species. Further studies, particularly of the indigenous species which are socially acceptable should be conducted. Such studies could include the effects of different silvicultural methods such as thinning regimes, spacing and pruning intensities on the growth and yield of such species.

SUMMARY

The survival of 22 species of exotic and indigenous multipurpose trees and shrubs grown in a 14-year old arboretum, located in Ibadan, South-western Nigeria was evaluated. The assessment was followed by wood yield analysis on 9 selected species which include *Cordia alliodora, Pterocarpus soyauxii, Treculia africana, Cassia siamea, Blighia sapida, Pentaclethra macrophylla, Dialium guineense, Gmelina arborea* and *Vitellaria paradoxa*. There was no significant provenance variation in the survival of all the species in the arboretum, but the selected species differed significantly in most of the growth and yield parameters. *Gmelina arborea*, an exotic species, recorded the highest wood yield (44.78 m^3/ha/year) while *Pterocarpus soyauxii*, an indigenous species, recorded the lowest wood yield (1.5 m^3/ha/year). Variations within species in wood yield were also observed. Linear regression equation for predicting yield from easily controllable variable like crown diameter was established for each of the species. Significant positive correlation coefficients between yield and crown diameter were obtained ($0.40 < r < 0.76$). The possibility of the use of the MPTS to develop a sustainable multiple land-use system is discussed.

दक्षिण – पश्चिमी नाइजीरिया के उष्ण वर्षा वनों में कतिपय बहुपयोजन वृक्षों की बढ़वार और प्राप्ति का तुलनात्मक अध्ययन

जे०एस०ए० ओशो व जी०एन० एजोनिना

सारांश

दक्षिण – पश्चिम नाइजीरिया के इबादान स्थित 14 वर्षीय वृक्षालय में ऊगाई जा रही देशी और परदेशीय बहुप्रयोजन वृक्षों और क्षुपों की 22 जातियों की अतिजीविता का मूल्यांकन किया गया । इस आकलन के उपरान्त चुनी हुई 9 जातियों की काष्ठ प्राप्ति का विश्लेषण किया गया जिनमें *कौर्डिया एलियोडोरा, प्टेरोकार्पुस सोयाक्सीआई, ट्रेकुलिया आफीकाना, सेन्ना सियामिआ, ब्लाइट सैपिडा, पेंटाक्लेथरा मैक्रोफिला, डायालुइम गिन्नीएंसिस, मेलिना आर्बोरिया* और *वाइटेल्लेरिया पैराडोक्सा* को लिया गया था । वृक्षालय में उगाई गई सभी जातियों की अतिजीविता में कोई सार्थक स्थानज अन्तर पड़ता नहीं पाया गया।

परन्तु चुनी गई जातियों की बढ़वार और प्राप्ति के अधिकांश परिमापों में सार्थक अन्तर मिला । परदेशीय जाति, *मेलिना आर्बोरिया* में सर्वाधिक काष्ठ प्राप्ति (44.78 मी$_3$/हेक्टे० /वर्ष) होती पाई गई जब कि यहीं की देशज जाति *प्टेरोकार्पुस सोयाक्सीआई* की प्राप्ति सबसे कम (1.5 मी$_3$/हेक्टे० /वर्ष) रही । विभिन्न जातियों की काष्ठ प्राप्ति में भी अन्तर पड़ता देखा गया । प्रत्येक जाति के सुगमता से नियन्त्रणीय विचारों जैसे छत्रव्यास की प्राप्ति पूर्व कथन के लिए रेखीय प्रतीपायन समीकरण भी बनाए गए । प्राप्ति और छत्रव्यास में सार्थक धन सहसंबन्ध गुणांक प्राप्त किए गए ($0.40 < r < 0.76$)। दीर्घकाल तक चल सकने वाली भूमि उपयोग प्रणाली विकसित करने के लिए एमपीटीएस की संभावना का विवेचन भी किया गया है ।

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INSECT PEST STATUS OF POPLARS IN INDIA

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Introduction

Poplars, in India, more particularly the exotics, have proved to be highly soft target to insect attack both in nurseries and plantations. The study of Poplars assumes special significance as a number of indigenous species have attained potential pest status, causing occasionally serious economic losses in growth increment or outright terminal mortality of the growing stock. Generally cultivated Poplars growing in hygienically healthy environment suffer only marginally from insect damage. There is also growing evidence to suggest that the loss in increment becomes appreciable when more than half of the foliage is lost. Precisely complete defoliation late in the growing season (i.e. August-September), causes the most serious damage, because the extended period of leaflessness reduces the plant vigour, making it more susceptible to a whole range of insect pests and other biological determinants. About 120 insect species have so far been found associate with damage to various species and clones of Poplars. While most of them are polyphagous and are casual visitors, a few of them are a real menace and have become a limiting factor in successful cultivation of Poplars. The indigenous insect fauna recorded on Poplars in India comprise chiefly Defoliators (58 species), Stem and shoot borers (23 species), Sap-suckers (27 species), Termites (4 species), Cockchafers (7 species) and Acarina (1 species).

A. Nursery Pests

Roots of Poplars in general, have been found susceptible to white-grub damage of *Oryctes nasicornis* (Coleoptera : Dynastinae), *Granida albosparsa*, *Hilyotrogus holosericea*, *Holotrichia longipennis*, *Melonlontha melolontha* and *Protaetia impavida* (Coleoptera : Melolonthinae) in nursery beds during May-June. While the chafer-grubs feed on the roots of Poplars, the adult beetles nibble leaves, making holes in them. Appreciable amount of mortality of Poplar stools has been recorded from Shilli Nursery, Solan (H.P.) (Singh and Singh, 1986).

B. Plantation Pests

Defoliators

Chrysomela populi (Coleoptera : Chrysomelidae) is an important defoliating beetle on Poplars (*Populus ciliata*) in the temperate Himalayan region from Kashmir to Arunachal Pradesh. Severe defoliation causes die-back in shoots and serious loss in increment. If not controlled it is likely to affect Poplars in forest nurseries and also increase the possibilities of its spread in the entire Kashmir Valley and the adjoining hilly State of Himachal Pradesh (Rishi, 1981) *Plagiodera versicolora* is another chrysomelid leaf beetle which infests the foliage of Poplars and willows from April to June. Heavily infested trees become entirely brown by September end (Singh and Singh, 1986).

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Some species of curculionid genus *Myllocerus* (*M. cardoni, M. discolor* and *M. pastuletus*) feed openly, in light to moderate intensity, on the foliage of various clones of *Populus deltoides* in Mala and Campierganj Poplar nurseries (Uttar Pradesh) (Thakur, 1981). Among the lepidopterous defoliators, the Indian tent caterpillar *Malacosoma indica* (Lasiocampidae) is a common species on Poplars (*P. ciliata*) in the hilly areas of Himachal Pradesh and Uttar Pradesh (India) and Pakistan. The larvae feed gregariously at night on young foliage, buds and inflorescence, at times, resulting in severe defoliation and failure of seed crops. Repeated defoliation kills the trees. Some of outbreaks are reported to have collapsed due to a bacterial disease in Kumaun and Mussoorie hills (Browne, 1968; Singh and Singh, 1986). Another species, *Malacosoma kashmirica* is an important and most serious pest recorded on Poplars in Kashmir Valley (Rishi, 1981). Infestation is noticed in summer (April-June) and for the rest of the period, it remains under dormancy in egg stage. The damage symptoms are more or less similar to that of Indian gypsy moth but can be distinguished by the presence of silken webbed tents on the branches. Poplars in nurseries are completely defoliated.

The Indian gypsy moth, *Lymantria obfuscata* is one of the principal pest on foliage of Poplars (*P. alba, P. ciliata* and *P. nigra*) in the Himalaya, particularly in Kashmir Valley. The larvae feed mostly during dawn and dusk in June-July and at places, the plantations are completely defoliated. Repeated defoliation in successive years causes proliferation of branches and loss in increment and consequent bushy appearance. The severely infested trees rarely survive (Rishi, 1981).

The Poplar defoliators, *Clostera cupreata* and *C. fulgurita* (Notodontidae) occur in Jammu and Kashmir, Garhwal, Kumaun and adjoining plains in Tarai region of Uttar Pradesh, Haryana and Punjab. Though originally reported from *Salix* (*S. tetrasperma*), these species have in recent years, adopted *Populus* as a palatable host in the plantations of Indo-Gangetic plains. Serious epidemic defoliations have been reported from some localities in Punjab and Tarai region of Uttar Pradesh. The attack starts in the months of March-April and continue till leaf fall. These pests are attacked by a number of egg and larval parasites and Nuclear Polyhedros Virus (NPV) which effectively control the upward trend of the pest population.

Neocera wisei (Notodontidae) the double-tailed caterpillar has been recorded from Poplars and Willows in northern regions of India and Pakistan. Larvae are voracious feeders, consuming most of the tissue, except the midrib. Occasionally, severe infestations have resulted in complete defoliation and subsequent mortality.

Stem and Shoot-borers

Larvae of several coleopterous and lepidopterous species constitute an important group of wood-borers in intensively managed Poplar plantations. Some of them are of great concern because of high economic loss caused by technical degradation induced in attacked trees. While the adults feed on foliage and tender bark, the larvae bore into the wood.

Several species of bark and sapwood boring beetles, especially those feeding on weakened trees, are of great concern in dry areas. Larvae of *Capnodis kashmirensis* (Coleoptera : Buprestidae) tunnel into the sapwood and cause considerable injury to Poplars in nurseries and plantations in Kashmir Valley. *Capnodis miliaris* is a well established pest in India, Pakistan and the Near-East on *Populus alba*, *P. euphratica* and *P. nigra*. It has also been reported from North Africa and Southern Italy in 1970. Poplars damaged during storms or injuries are the most soft targets.

Other Buprestid borers are *Chrysobothris femorata* and *Melanophila picta indica* which are actively associated with Poplars. *Chrysobothris femorata* occurs widely in America, Canada (Baker, 1972) and India (Rishi, 1981). The adults are active during summer, feeding on the foliage causing occasionally serious defoliation. The larvae bore into the bark and feed in the phloem and outer sapwood.

The species attacks mostly the newly planted or drought affected trees. Young trees are often girdled and killed. Large and mature trees are often seriously injured, through the loss of large patches of barks over the mined areas. The species has also been recorded on Poplars causing considerable damage, in nurseries in Kashmir Valley (Rishi, 1981).

Melanophila picta, has been reported from India, Pakistan and some Middle-East countries (Iraq). In India, the pest has been reported from *Populus euphratica* (Beeson, 1941). Many trees have been reported getting dried after serious attack of this pest. In Iraq, 6-10 years old hybrid Poplars are reported to have succumbed to epidemic infestation of this pest resulting in suspension of further cultivation of Poplars (Choudhry and Ahmad, 1973).

The Cerambycid long-horn beetles, which are capable of causing high economic losses in living trees of Poplars, are *Aeolesthes sarta, Apriona cinerea, Batocera rufomaculata* and *Macrotoma crenata*.

Aeolesthes sarta, nick-named as Quetta borer, is reported to have caused extensive damage in avenues of Poplars, willows and elms in the year 1900-1907 in Quetta and throughout Baluchistan. Larvae destroy the bark and sapwood, causing cessation of growth. The heavily infested Poplar trees dry up in 3-4 years. Usually the attack recurs for several years in succession, often killing the host by girdling (Browne, 1968).

Apriona cinerea, the Poplar stem borer is common in North-West India. The beetles feed on bark and young shoots, larvae make extensive tunnels both upward and downwards and enter the roots. The cultivation of exotic *Populus* spp. has been seriously affected by this borer in Uttar Pradesh (Mathur, 1962). It is one of the most important xylophagous insects, recorded destroying various species and clones of Poplars, *P. casale, P. deltoides, P. x-euramericana, P. generosa, P. nigra, P. nigratrichocarpa, P. regenerata, P. robusta* and *P. yunanensis* (Sen-Sarma and Gupta, 1981). The Poplar plants do not die but remain green and healthy (Chatterjee and Thapa, 1964). Most of the attack occurs in 1-3 years plantations and large trees are altogether free from attack (Sen-Sarma and Gupta, 1981). The stem becomes weaker and prone to breaking off by wind or otherwise. Sohi (1990) has reported about 2-5% Poplar trees seriously infested by this borer in the sub-montane tract in Punjab.

Batocera rufomaculata occurs widely in the Oriental region and also Malagascan region, the Near-East, and the Caribbean

Islands. In India, it is reported to be a pest of *Populus x-euramericana*. The beetle is nocturnal in habit and feeds by gnawing bark of twigs as well as green growing tips. The species is known to kill trees directly by heavy attacks (Browne, 1968).

Zeuzera coffeae is an important borer of woody stem and branches of young living saplings of Poplars, results in die-back of affected portion (Sen-Sarma and Gupta, 1981). It has also been reported from forest nurseries and one year old plantation of *P. deltoides* in West Bengal (Veer and Chandra, 1984).

Among the shoot-borers, *Eucosma glaciata* (Eucosmidae) is an important pest on young plants of *Populus* spp. in North-West Himalayas. Larvae are active in June-July. They bore the tips of the shoots, eating their way downwards. It is one of the most destructive pests of young Poplars in nurseries, more particularly of *Populus ciliata, P. deltoides*, and *P. yunanensis*. Heavy attack results in stagheaded plants.

Trees of all ages of Poplars are reported to have been attacked by *Indarbela quadrinotata* but the incidence is more serious on older trees and in neglected plantations. 2-5% loss has been recorded in Poplars because of increased vulnerability to breaking by wind.

Sap-suckers

Sap-sucking insects affecting Poplars both in nurseries and plantations include chiefly aphids and scale insects. Aphids feed on leaves and tender shoots in large colonies and cause stippling, browning and ultimately defoliation of the leaves from July to November (Sohi, 1990). Several of these insects are suspected of being in addition, agents in the transmission of diseases and other pathogenic infection (Anon., 1978). The scale insects attack shoots, stems and twigs of young trees, resulting in withering and death of the affect plants.

While *Aphis populi, Chaitophorus populus* are commonly associated with damage to the foliage of *Populus alba*, the *Chaitophorus kapuri* and *Tetraneura* sp. have been recorded from stem of *Populus ciliata* in Kashmir Valley.

About half a dozen species of the palaearctic genus *Pemphigus* (Aphididae) are similarly reportedly involved with damage to foliage of various species of Poplar in India. The attack causes cellular malformation (galls) (Browne, 1968). The damage, more particularly to growing tips of young shoots, is of high economic significance.

Of the known species of *Pemphigus* on various species of *Populus* in the Himalayan region are *Pemphigus imicus, P. mordwilkoi* and *P. nainitalensis* on *Populus ciliata* and *P. nigra* var. *italica, Pemphigus immunis* on *Populus nigra* and *Populus tremula* and *Pemphigus napaeus* on *Populus ciliata* and *P. euphratica*.

The giant willow aphid, *Tuberolachnus salignus* is found, with irregular distribution, in the temperate regions of Africa, America, Europe, and Asia including India, often occurring in large colonies on the stem, branches and twigs of Poplars and Willows. The feeding stains the wood and renders it useless for basketry (Browne, 1968). Sometimes, fairly large trees are killed. The problem is further aggravated by the development of associated sooty moulds on the honeydew.

Among the scale insects, *Quadraspidiotus pernicious* (Diaspididae), the San Jose scale, has emerged as the most important sap-sucking pest of Poplars in the Himalayan region (Rishi, 1981). A native of northern China, cosmopolitan pest of Orchards in many parts of the temperate zones (Caesar, 1914; Browne, 1968). From India, it was first reported in 1911. Today, it is an established and most widely distributed pest in Jammu and Kashmir and Himachal Pradesh requiring regular sprayings (Rishi, 1981).

The gall forming psyllid, *Phylloplecta gardneri* and its allied species make flattened, unicellular yellowish to dark green galls on both the surfaces of the leaves of *Populus euphratica* and clones of some other *Populus* spp. in the North-Western Indian region. The formation of galls on Poplar twigs though causes drainage of certain amount of sap and affect the growth of the plant, it does not however, kill the plant.

Poplar leaf curlmite, *Tetranychus urticae* (Acarina : Tetranychidae) has been reported on various clones of Poplars (G-48 and D-121) in India and Pakistan. Both adults and nymphs feed on the terminal foliage and tender stems, during July-August, causing stunting and malformation of leaves, terminal tips and buds as well as loss of immature foliage. Heavily attacked leaves become crinkled. Small developing leaves generally break-off, making terminal shoots leafless. Debilitation and death occurs as a result of massive feeding of this species.

Termites

Termites have been reported as a serious menace in Poplars in Tarai region of Uttar Pradesh (Thakur, 1981). The species implicated with damage are *Heterotermes indicola*; confined only to outer bark portion, *Coptotermes heimi, Odontotermes distans* and *O. obesus*. The termites gain entry either through the roots or injury on the stem near the ground level. Having once gained entry, they work upward and radially in the main bole, ultimately making the trees hollow. The trees thus damage are rendered useless and prone to wind break. Of all the termite species, *Coptotermes heimi* is the most serious causative factor for die-back and mortality in some clones (65/27) of *Populus deltoides* and which was resulted in the rejection of this otherwise beautiful and very vigorously growing clone for large scale plantation in Uttar Pradesh. Termite damage of serious proportion was also observed on casale clones, (*casale* I-15 and I-488), which were initially categorised as clones of good promise and were recommended for planting in Uttar Pradesh. *P. deltoides* (Ic clone), because of poor growth was found seriously damaged by termites in Campierganj, Gorakhpur (U.P.).

Timber Pests

Though, like most other timber species, felled and converted wood of all species and clones of Poplars are known to be prone to attack, in varying degree, to borers, but there are very few published records available in literature.

Larvae of *Tropiderinus munieri* (Anthribidae) and *Capnodis miliaris, Chrysobothris* sp. and *Melanophila picta* bore in deadwood of *Populus euphratica*. Among long-horn beetles, *Aeolesthes sarta* has been recorded on deadwood of *Populus alba* and *P. euphratica*, *Purpuricenus indus* and *P. haussknecht* on *Populus ciliata* while *Stromatium barbatum* has been reported from drywood of *Populus ciliata* and *P. tremula*.

Among the bark beetles, *Crossotarsus wilmoti* bore in the freshly felled and fallen wood of *Populus ciliata* while beetles and larvae of *Lyctus africanus* bore in the sapwood and converted wood of *Populus euphratica*.

SUMMARY

Poplars, especially the exotics, are the soft targets of indigenous fauna. The 120 and odd species, comprise chiefly cockchafers (7 species), defoliators (58 species) stem and shoot borers (23 species), sap-suckers (27 species), termites (4 species) and mites (1 species). The nursery pests include white-grubs of scarabaeid beetles which feed on roots and cause sometimes, appreciable mortality in Poplar stools. The *Chrysomela populi, Lymantria obfuscata, Clostera* spp. (*C. cupreata* and *C. fulgurita*), *Capnodis* (*C. kashmirensis* and *C. miliaris*),*Chrysobothris femorata, Melanophila picta* (Buprestidae), *Aeolesthes sarta, Apriona cinerea, Batocera rufomaculata* (Cerambycidae) and *Zeura coffeae* (Cossidae) are important stem-borers.*Eucosma glaciata* and *Indarbela quadrinotata* are serious shoots borers of young, and old Poplar plantations respectively. Sap-sucking insects affecting Poplars include chiefly aphids (*Aphis populi, Chaitophorus populus, Pemphigus* spp.) and scale insect (*Quadraspidiotus perniciosus. Phylloplecta qardneri* (Psyllidae) causes drainage of sap by its gall forming activities. While *Coptotermes heimi* and *Odontotermes distans* are the primary causative factor for die-back and mortality in certain clones, the coleopterous borers, chiefly - *Tropiderinus munieri* (Anthribidae), and *Stromatium barbatum* and *Lyctus africanus* depreciated significantly timber of Poplars by their larval activities. The bark-beetle *Crossotarsus wilmoti* bores in freshly felled and fallen wood.

भारत में पोपलरों (वनपिप्पलों) के नाशिकीटों की स्थिति

एम० एल० ठाकुर

सारांश

वनपिप्पलों (पोपलर), विशेषतः परदेशीय, देशी कीड़ों-मकोड़ों के लिए मुलायम आक्रमण केन्द्र हैं । इनकी 120 से कुछ ज्यादा कीट जातियों में मुख्यतः शाक भृंग (सात जातियाँ), पिष्पत्रक (58 जातियाँ) तना और प्ररोह छिद्रक (23 जातियाँ), रसचूषक (27 जातियाँ), दीमकें (4 जातियाँ) और बरुथी (1 जाति) आती हैं । रोपणी स्तर में लगते नाशिकीटों में स्कैराबिड भृंगों के श्वेत भक्षीजातक सम्मिलित हैं जो इसकी जड़ों से पोषित होते हैं और कभी-कभी वन पिप्पलों के स्थूणों को काफी नष्ट करते हैं । महत्वपूर्ण तना छिद्रकों में *क्राइसोमेला पोपुलि, लायमेंट्रिया ओब्फुस्काटा, क्लोस्टेरा* की जातियाँ (*क्लो० क्युप्रेआटा व क्लो० फुल्गुरिटा) कैप्नोडिस* की जातियाँ (*कै० कश्मीरेंसिस और कै० मिलियारिस) क्राइसोबोथ्रिस फेमोराटा, मेलानोफिला पिक्टा* (ब्युप्रेसटिडी वंश) *एओइलेस्थिस सार्टा, एप्रियोना सिनेरिआ, बाटोसेरा रुफोमैकुलाटा* (सेराम्बाइसिडी वंश) और *जेऊरा कोफेइ* (कौस्सिडी वंश) महत्वपूर्ण तना छिद्रक हैं । *युकोस्मा ग्लेसियाटा* और *इण्डरबेला क्वाड्रिनोटेटा* क्रमशः नए और पुराने वन पिप्पल रोपवनों में लगने वाले गम्भीर प्ररोह छिद्रक हैं। वन पिप्पलों पर कुप्रभाव डालने वाले रस चूसक कीड़ों में मुख्यतः द्रुयूका *(एफिस पोपुलि, कायटोफोरस पोपुलस, पेम्फिगस* की जातियाँ) और शल्कि कीट *(क्वाड्रास्पिडियोटस पर्निसियोसस)* आते हैं । *फायलोप्लेक्टा क्वार्डनेराइ* (साइल्लिडी वंश) अपनी गुम्मड़ बनाने की क्रिया से इसका रस बहाने का काम करता है । कतिपय कृन्तकों के मुरझा जाने और मरण के लिए यद्यपि *कोप्टोटर्मिस हायमाइ* और *ओडोण्टोटर्म्सि डिस्टैंस* ही प्रथम कारण भूतकारक है । कंचुकपक्ष छिद्रक मुख्यतः *ट्रोपिडेरिनस मुनिएराइ* (एन्थ्रिबिडी वंश) और *स्ट्रोमेशियम बार्बेटम* व *लिक्टस एफ्रिकानस* अपने जातकों की क्रिया से वन पिप्पलों के प्रकाष्ठ को काफी हानि पहुँचाते हैं । छाल भक्षी भृंग *क्रोसोटार्सस विल्मटाई* ताजे काटे और गिरे-पड़े काष्ठ में छेद बना डालते हैं ।

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PLANT SPECIES DIVERSITY AND COMMUNITY STRUCTURE IN THE OUTER FRINGES OF KEDARNATH WILDLIFE SANCTUARY, WESTERN HIMALAYA : CONSERVATION IMPLICATIONS

G.S. RAWAT*, S. SATHYAKUMAR* AND S. NARENDRA PRASAD**

Introduction

The forest formations in the Himalaya originated and evolved from the tropical forests of Indian peninsula under the influence of orogenic, bio-edaphic and climatic changes (Vishnu-Mittre, 1984). Over 15 forest types are known to occur in the Himalayan region which are distributed along a wide altitudinal range (Champion and Seth, 1968) and support a rich array of flora and fauna. These forests terminate at a distinct ecotone i.e. treeline towards higher altitude (3500 ± 200 m above mean sea level in the Western Himalaya and 3800 ± 200 m in the Eastern Himalaya). Towards lower altitudes, especially in the Western Himalaya, most of the forests are bounded by extensive human habitation, agriculture and other land use practices.

The evergreen forests dominated by Oaks (*Quercus* spp.) are regarded as climax vegetation in this region (Singh and Singh, 1988). In the Western Himalaya, low-mid elevation Oak forests are represented by the Banj Oak (*Quercus leucotrichophora*) - Rhododendron (*Rhododendron arboreum*) community which is quite vulnerable due to anthropogenic pressures such as encroachment for agriculture, livestock grazing, lopping for fodder and fuelwood, and exploitation for various Non-Timber Forest Products (NTFPs). These pressures are generally manifested along the gradient of decreasing climax communities, and increasing secondary and weedy species. At present, very few sizeable patches of undisturbed Oak-Rhododendron forests can be seen in the Western Himalaya due to various pressures. Large scale destruction of forests in many sectors of Himalaya have resulted in several environmental problems (Singh, 1985; Ives and Messerli, 1989).

There have been a few ecological studies covering the community structure and phytosociology of Oak forests, e.g., Osmaston (1926), Gupta and Singh (1962), Ralhan *et al.* (1982), and Singh and Singh (1986). However, comprehensive studies are lacking on the patterns of species diversity and regeneration along the human use gradients. Such studies, particularly in and around protected areas, can serve as baseline information and would be useful in predicting the future course of succession and habitat conditions in the Himalaya. The paper, represents a case study on the Banj Oak forests in the outer fringe of Kedarnath Wildlife Sanctuary (WS), a protected area in Western Himalaya with reference to species diversity and regeneration status, to discuss the

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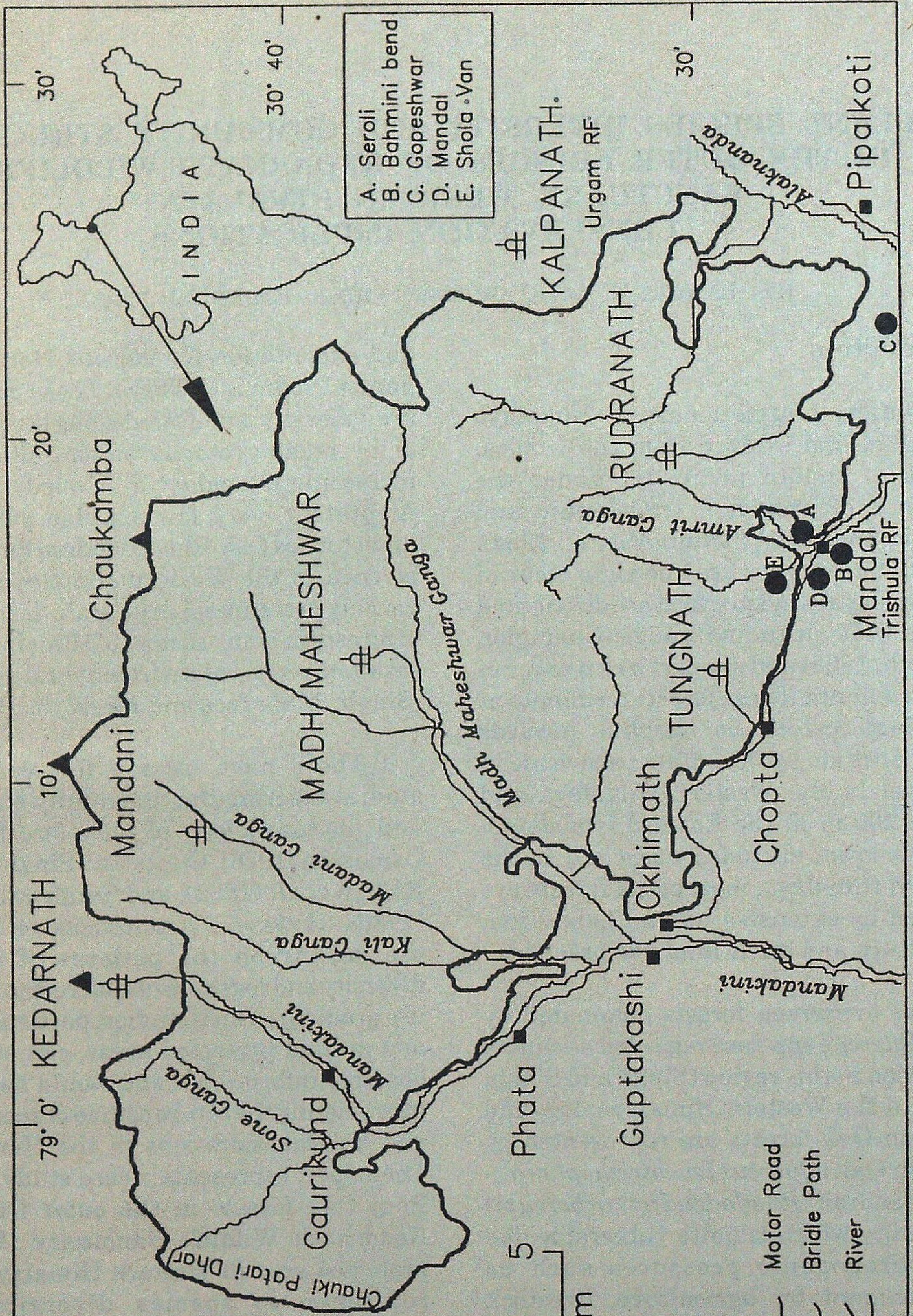
Fig. 1


A. Seroli
B. Bahmini bend
C. Gopeshwar
D. Mandal
E. Shola - Van
INDIA
30'
20'
10'
79° 0'
30° 40'
30'
N
0
5
km
Motor Road
Bridle Path
River
KEDARNATH
Mandani
Chaukamba
MADH MAHESHWAR
KALPANATH
Urgam RF
RUDRANATH
TUNGNATH
Trishula RF
Pipalkoti
Mandal
Chopta
Okhimath
Guptakashi
Phata
Gaurikund
Chauki Patari Dhar
Sone Ganga
Mandakini
Kali Ganga
Madani Ganga
Madh Maheshwar Ganga
Amrit Ganga
Alaknanda
A
B
C
D
E

Kedarnath Wildlife Sanctuary with location of study sites conservation implications of various levels of human pressure in the region.

Material and Methods

The study was conducted along the outer fringes of Kedarnath WS (975 km^2; *ca.* 30°25' - 30° 45'N and 78° 55' - 79° 22'E) located in Chamoli District, Uttar Pradesh (Fig. 1). The study area is bounded by several villages in the South and cool temperate forests in the North. The mean annual precipitation is quite high (>3000 mm) as compared to the other areas in Western Himalaya (Green, 1985; Singh and Singh 1988, Sathyakumar, 1994). Of this, 8-10% is in the form of snow during winter (December-March) and a major portion as rain (>65%) during monsoon i.e. June-September (Green, 1985; Sathyakumar, 1994). About 5% forest in this area belongs to Village Panchayat, mainly consisting of Banj Oak, Oak-Rhododendron, scattered patches of Chir pine (*Pinus roxburghii*) and various stages of degradation (Negi, 1982). The Champion and Seth's (1968) equivalents to these Oak forests are : Lower Western, and Upper Western Himalayan Moist Temperate Forests (12/C1 and 12/C2). The local people are primarily agro-pastoralists and collect fuelwood and fodder from these forests.

Five sampling sites were selected for intensive study (Fig. 1). They are: (A) Seroli village forest, (B) Bahmini Bend (Trishula

Table 1

Bio-physical conditions of study sites in the outer fringes of Kedarnath Wildlife Sanctuary

Site Name	Status	Altitude (m)	Major landuse	Site characteristics Vegetation type
A. Seroli	Village Forest	1700-1900	Village pasture. Wood cutting, lopping.	Secondary scrub quartzite,limestone, thin clayey soil
B. Bahmini Bend	Trishula RF/ Village Forest	1600-1700	RF/Village forest. Grazing, lopping.	Oak forest (lower) Partially degraded Quartzite, clayey loam soil
C. Gopeshwar	Village Forest	1550-1700	Panchayat (Community) Forest. Leaf litter and grass collection. No lopping.	Dense pure Oak (pure) Limestone rocks, thin soil protected by villagers.
D. Mandal	Trishula RF	1750-1900	Reserved forest. Firewood and leaf litter collection.	Dense Oak mixed broad leaf forest, moist clayey-loam soil
E. Shola Van	Wildlife Sanctuary	1600-1700	Wildlife Sanctuary. No grazing and lopping; occasional bamboo collection.	Dense forest Schist and quartzite, Deep clayey loam, Deep leaf litter

Table 2

Density and Richness of woody species at various sites in the outer fringes of Kedarnath Wildlife Sanctuary

Site	Tree Density (no. ha^{-1}±SD)	Shrub Density (no. ha^{-1}±SD)	Species Diversity (H')		Total No. of woody species
			Tree	Shrub	
A. Seroli	380.0±181.9	180.0±8.7	1.432	0.795	18
B. Bahmini Bend	265.6±210.9	11080.8±7386.3	1.520	2.306	39
C. Gopeshwar	989.2±245.2	10953.6±7373.6	0.651	0.928	15
D. Mandal	888.4±254.2	6979.3±3213.5	2.000	2.743	32
E. Shola Van	448.5±165.4	13943.3±11055.4	2.297	0.775	34
ANOVA (F value)	32.61***	2.99^{NS}			

^{NS} = non-significant; ***=P<0.001

Reserved Forest), (C) Gopeshwar Village Panchayat forest, (D) Mandal (Trishula Reserved Forest), and (E) Shola Van (inside Kedarnath WS). These sites represent various stages of degradation with the same elevation range i.e. 1550-1900 m and aspect (South - South-East), hence taken for comparison (Table 1). In each sampling area 20 circular plots of 10 m radius (*ca.* 314 m^2) were laid randomly to record the tree species, their abundance and girth class distribution. Shrub species including Ringal Bamboo (*Arundinaria falcata*) and tree sapling were enumerated within 5 m radius plots concentric to the larger plots. At two sites (A and D) we used slightly larger (10.3 m radius) plots for tree species which was required for a separate study (Sathyakumar, 1994). The ground cover and litter depth were estimated using point intercept method. Common herbs and grasses were also recorded at each sampling point. The Important Value Index (IVI), which is the integrated measure of relative density, relative abundance and relative dominance, was calculated for tree species. All the sites were compared in terms of species diversity using Shannon-Wiener index (Shannon and Wiener, 1963) for trees and shrubs separately.

Results and Discussion

The density and diversity of woody species have been given in Table 2. There was a significant variation in the tree density among various sites (ANOVA, p<0.001). The least disturbed site (Shola Van) had a moderate tree density (448.50±165.40 ha^{-1}) while protected and artificially stocked forest at Gopeshwar had highest tree density followed by a mesic site with several broadleaf species as associates of Banj Oak. There was a considerable variation in shrub density within each site as reflected by high values

Table 3

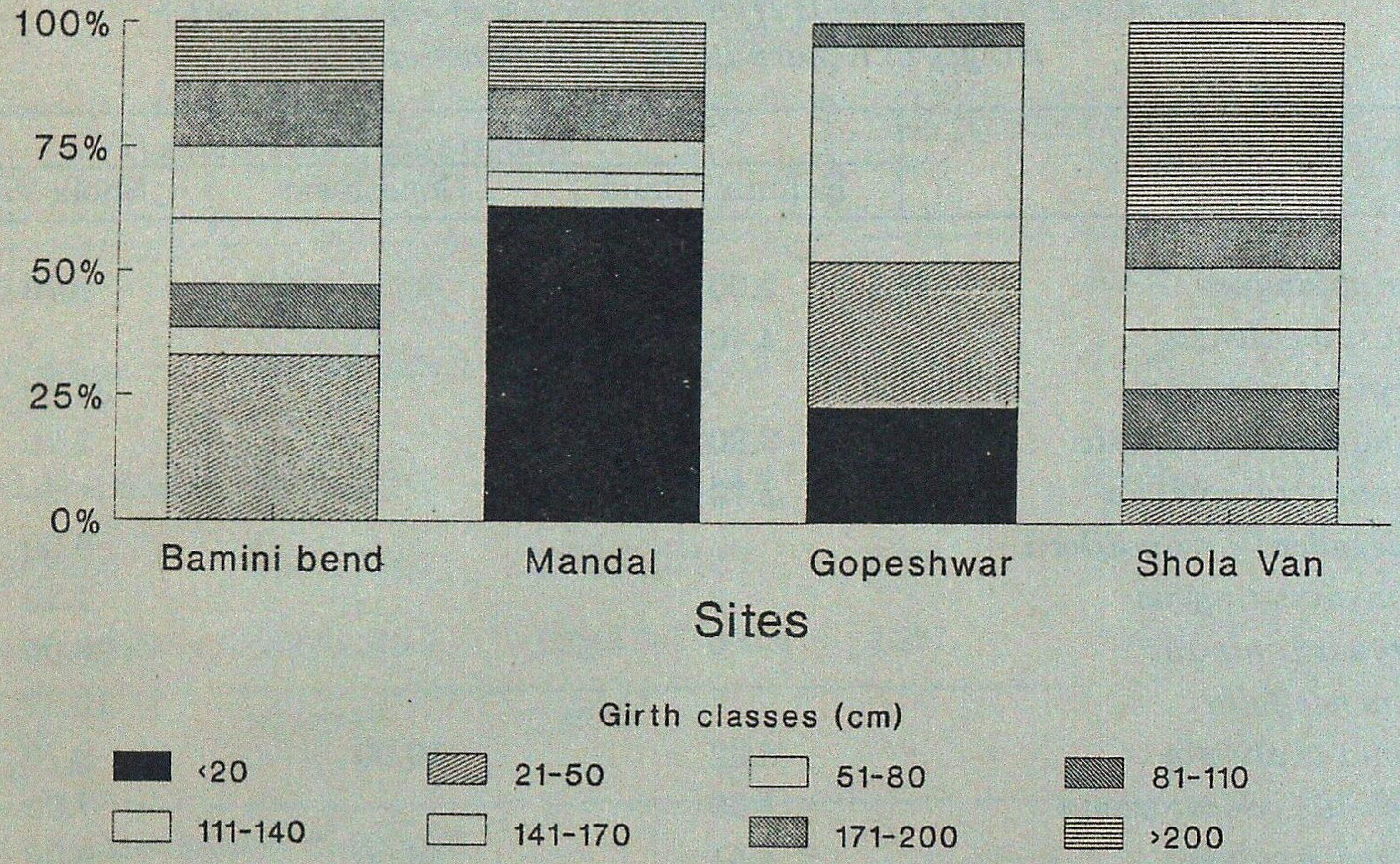
Importance Value Index (IVI) of tree species at sites in the outer fringes of Kedarnath Wildlife Sanctuary

Species	Importance Value Index (IVI)		
	Bahmini Bend	Gopeshwar	Shola Van
Acer oblongum	2.00	-	9.70
Alnus nepalensis	4.40	-	-
Carpinus viminea	-	-	33.80
Cinnamomum tamala	3.30	-	1.70
Cornus macrophylla	2.70	-	-
Dodecadenia grandiflora	-	-	9.30
Euonymus tingens	-	-	1.10
Eurya acuminata	-	-	20.00
Ficus nerifolia	-	-	10.30
Lyonia ovalifolia	8.02	19.00	9.70
Machilus odoratissima	1.30	-	7.00
Myrica esculenta	1.51	48.00	9.00
Osmanthus fragrans	-	-	24.10
Pinus roxburghii	-	6.00	-
Prunus cerasoides	8.10	-	-
Pyrus pashia	5.43	-	-
Quercus glauca	-	-	31.90
Q. leucotrichophora	100.60	206.79	48.70
Rhododendron arboreum	15.10	22.20	52.40
Rhus semialata	-	1.60	5.80
Symplocos crataegoides	1.80	-	-
Syzygium jambolana	-	0.80	-

of SD. However, variations in shrub density among the sites were not significant. This could be due to patchy distribution of Ringal Bamboo and a large number of bamboo culms which were taken into account for the estimation of shrub density. This explains the unusually high shrub density for an old growth forest i.e. Shola Van. The richness of woody species was highest (39), at fringe forest (Site B), followed by old growth forest (34), mesic site (32), secondary scrub (18) and artificially raised forest following the landslide (15). Mean number of tree species per plot varied from 2-8 while for shrubs it was 3-7.

The diversity of tree species was highest in old growth forest (H'=2.297) while village forest at Gopeshwar had least diversity of tree species (0.651). It is

Fig. 1



Girth Class distribution of Banj Oak (*Quercus leucotrichophora*) at different sites

interesting to note that the old growth forest had least shrub diversity (H'=0.775) while mesic and slightly disturbed forest of Mandal had the highest diversity at shrub layer (H'=2.743) followed by forest edge near Bahmini bend (H'=2.306). These results tend to support the popular notion that the habitats characterized by moderate level of disturbance provide more opportunity for species turnover, colonization and the persistence of high species richness (Whittaker, 1975; Connell, 1978). However, a critical look at the species composition at various sites reveals that frequently lopped and grazed sites were predominated by thorny, weedy and ruderal species. A few unlopped trees at site B were covered with epiphytic species such as *Peperomia reflexa, Drynaria* sp. *Polypodium* sp., and *Dendrobium normale* (a rare endemic orchid from temperate Oak forests of Uttar Pradesh, Himalaya). The old growth forest was rich in climbers (7 species), mosses and a few sciophytic herbs e.g., *Pilea wightii* and *Strobilanthus atropurpureus*.

A comparison of IVI values at three sites (Table 3) shows that *Q. leucotrichophora* was the dominant species at all the sites with *R. arboreum* as co-dominant species. *Carpinus viminea, Machilus odoratissima* and *Quercus glauca* were quite prominent in old growth forest (Shola Van). Data on the girth class distribution of *Q. leucotrichophora* (Fig. 2) indicates that moderately disturbed area with very little livestock grazing had best Oak regeneration. Both old growth and frequently lopped forest had no seedlings and saplings within the sample plots. At the Panchayat forest (Site C) most of the

Oak trees were below 110 cm girth with nearly 3% saplings and seedlings. This forest patch has been protected by the villagers from lopping and livestock grazing subsequent to a landslide in 1961 (village head, pers. comm.). It cannot be asserted whether the site has become ideal for the regeneration of Oak or not. In parts of Kumaun Himalaya it has been observed that Banj Oak saplings appear after 20 years of protection once the site is damaged or reverted to bare inorganic substrate (Singh and Singh, 1986).

A comparison of understorey (shrub) species along the increasing human use gradient shows an interesting pattern. The relative abundance of *Arundinaria falcata* and *Myrsine africana* were highest in the old growth forest and decreased with increase in human pressure. On the other hand, thorny species such as *Berberis asiatica* and *Principia utilis* had maximum relative abundance in secondary scrub followed by forest edge, open forest and closed forest with complete absence in mature forest. Thus, many of these species can be used as indicators of succession or retrogression and for assessing the site condition. These species fall in the following categories of disturbance regime (after Dyksterhuis, 1949) :

1. *Decreasers* : These are the species which decrease with the increasing disturbance e.g., *Arundinaria falcata, Boehmaria platyphylla, Leptodermis lanceolata, Desmodium tilliaefolium*, and *Viburnum stellulatum*.

2. *Increasers* : These are the species which increase with the increasing disturbance, viz., *Axcoecaria acerifolia, Caesalpinia bonducella, Lonicera quinquilocularis, Myrsine africana, Pyracantha crenulata, Randia tetrasperma, Reinwardtia trigyna, Rhamnus virgatus* and *Xanthoxylum alatum*.

3. *Invaders* : These species invade the highly disturbed areas : *Berberis asiatica, Rosa moschata, Principia utilis* and *Sarcoccoa hookeriana*. This class of species is also characterized by the weedy, unpalatable herbs such as *Anaphalis contorta, Erigeron* spp., *Eupatorium adenophroum* and *Dryopteris* spp., indicating disclimax stage.

Sathyakumar (1994) found that the density estimates of wild mammals were relatively higher in Mandal, Shola Van and Bahmini bend while Seroli area had low abundance.

Conservation Implications

There are quite a few protected areas in the Western Himalaya (Rodgers and Panwar, 1988) but none of these give adequate representation to mid elevation Oak forests. Based on the analysis of aerial photographs Negi (1982) concluded that nearly 27% of the geographical area in Kedarnath WS has potential to bear Banj Oak forests but it had only 14% area under this category during 1980-81. Analysis of recent aerial photographs of this region could help in detecting changes in the forest cover, and shift in the forest boundary. Similarly, monitoring changes in the understorey species and vegetation structure would be useful for finding out the trends in habitat conditions and evolving conservation strategies for the area.

From the conservation point of view old growth forests as seen in Shola Van may be of utmost importance. Such forests provide structural as well as functional diversity which are very important for the health of temperate ecosystems (Franklin, 1988). The components of structural diversity in Shola Van include fallen logs, snags, multi-storeyed canopy, and moss-lichen laden tree trunks while nitrogen fixing and litter decomposing organisms may be the examples of functional diversity. Local people seem to be aware of the values of Oak forests, particularly their ability of moisture retention, and source of fuel, fodder and NTFPs, as indicated by them during our interviews, their folklores and conservation movements in the past (for instance, Chipko or tree hugging). Such an attitude may be helpful in maintaining the 'status quo' at some sites for a long period, provided the buffer (village) forests such as Bahmini Bend continue to meet the major biomass demands of local people and don't degrade rapidly. It is also noteworthy that not all the anthropogenic activities in the area may lead to degradation of forest and wildlife habitats. For example, grass cutting and cool season burning on steeper slopes may be helpful in maintaining the habitat for certain animals such as Goral (*Nemorhaedus goral*), Himalayan Tahr (*Hemitragus jemlahicus*) and endangered Chir Pheasant (*Catreus wallichii*). Other human activities such as regulated seasonal harvest of bamboo, fodder collection from the fringe forests and regulated livestock grazing in the designated areas may not alter the habitats drastically because the Oak forests are considered fairly resilient and compatible with the regional climate (Singh and Singh, 1986).

In order to conserve the whole gamut of plant and animal communities in the area and check the further degradation of key buffer forests it is recommended

(i) Continued cooperation between the villagers and management authorities of Kedarnath WS;

(ii) Eco-development measures for rehabilitation of highly degraded secondary scrubs near Mastura and lower parts of Mandal;

(iii) Alternative sources of energy (fuelwood) be provided to the villagers who are dependent mainly on the forests lying within the Kedarnath WS; and

(iv) Strict ban on the commercial exploitation of the buffer forests.

Acknowledgements

We wish to record our grateful thanks to Late Shri Vikram Singh Bisht and Shri Surendra Singh Negi for their assistance in field work. We thank the Uttar Pradesh Forest Department, particularly the field staff of Kedarnath WS for their help and cooperation during the course of this study. Shri S.K. Mukherjee, Director, WII and his predecessor Shri H.S. Panwar are acknowledged for their constant encouragement.

SUMMARY

Studies on the plant species diversity and community structure were carried in the outer fringes (1550m - 1900m) of Kedarnath Wildlife Sanctuary, Western Himalaya. Five sites were selected along the gradient of human use which represented various stages of Oak-Rhododendron *Quercus leucotrichophora - Rhododendron arboreum* community. The tree density varied significantly among the sites (ANOVA p<0.001) but there was no significant variation in the shrub density. The diversity of tree and shrub species have been compared separately at various sites using Shannon-Wiener index. The number of woody species was highest in the moderately disturbed site where as lowest in the Oak forest protected and artificially regenerated by the villagers. Moderately disturbed site showed best regeneration of ban Oak. However, maximum tree species diversity, structural (and possibly functional diversity) are exhibited by the old growth forest. Indicators of different seral stages have been identified and conservation implications discussed.

केदारनाथ पशु विहार, पश्चिमी हिमालय के बाहरी छोरों पर स्थित वनों में पादप समुदायों की विविधता और संरचना : संरक्षण के परिपेक्ष में

जी०एस० रावत, एस० सत्यकुमार व एस० नरेन्द्र प्रसाद

सारांश

हमने केदारनाथ पशु विहार, पश्चिमी हिमालय के बाहरी छोरों (1550-1900 मी०) पर स्थित वनों में पादप विविधता और उनके समुदायों की सरंचना का अध्ययन किया, इसके लिए विभिन्न जैविंक दबावों वाले पाँच अध्ययन स्थल चुने गये जो कि मूल रूप से बाँज-बुराँस (*क्वेरकस ल्यूकोट्राइकोफोरा रोडोडेन्ड्रोन आर्बोरियम)* समुदाय का प्रतिनिधित्व करते थे । वृक्षों व झाड़ियों की विविधता में अलग-2 तुलना की गई है । कम मध्यम दबाव वाले वन में काष्ठीय प्रजातियों की संख्या सर्वाधिक थी जब कि भूस्खलन के उपरान्त लगाए और बचाए गए जंगल में न्यूनतम प्रजातियाँ थीं । बाँज वृक्ष का पुनर्जनन भी मध्यम दबाव वाले जंगल में अच्छा पाया गया । अल्पतम दबाव वाले पुराने वन में वृक्षों की विविधता, संरचनात्मक (तथा सम्भवतः कार्यिक) विविधता सर्वाधिक आंकी गई । प्रस्तुत लेख में विभिन्न परिस्थितियों के सूचक प्रजातियों की पहिचान की गई है और सरंक्षण की दृष्टि से परिणामों का अभिप्राय समझाया गया है ।

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SOIL ORGANIC MATTER STATUS UNDER DIFFERENT SOCIAL FORESTRY PLANTATIONS

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Introduction

It has been invariably observed that Social Forestry plantations are raised on lands which are only marginally fertile. Developing a quantitative understanding of change in the soil organic matter especially with seasons, is likely to reveal the cause of poor performance. Soil humus is the most important part of the soil organic fraction which regulates soil fertility and productive potential of the forest areas. Dead plant parts are digested and decomposed by the different types of soil microorganisms and help in formation of soil profile. Soil organic matter retains the nutrients in reserve and makes it available in the soil through mineralization. Availability of nutrients changes by decomposing leaf litter of several species (Ghosh *et al.*, 1980). Properties of soil including its productivity have been affected by forest through accumulation of litter. The extent and quality of litter produced by forest depend upon the species, age of stand and tree density (Mathur and Bhatnagar,1964; Kaushik,1954). The influence of leaf litter, decomposition of organic matter largely determine the fertility level of the forest soil (Anon., 1978). Organic matter influences not only chemical but physical properties also (Auchmoody, 1972).

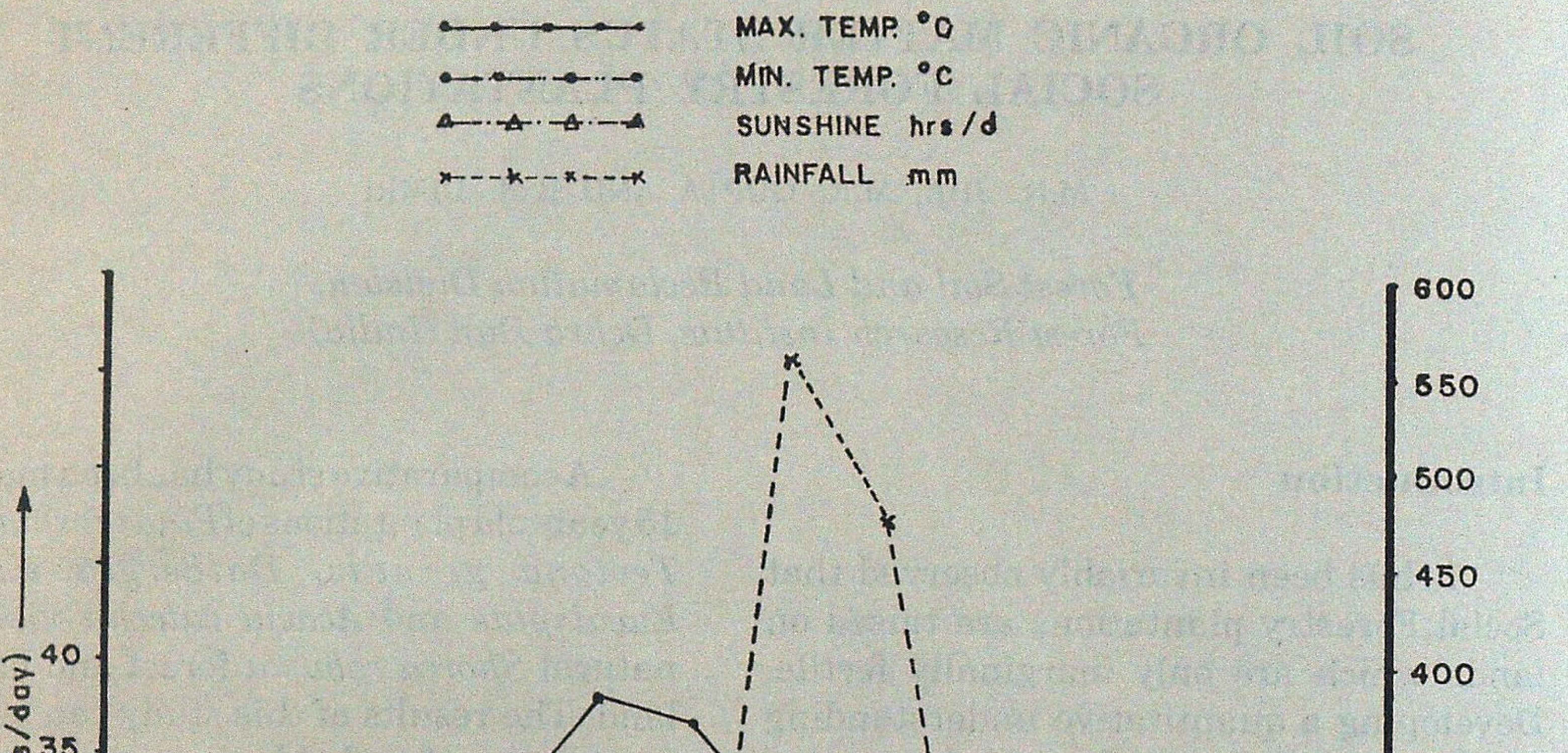
A comparative study has been made in 15 years old plantations of *Pinus roxburghii*, *Tectona grandis*, *Dalbergia sissoo*, *Eucalyptus* and *Acacia catechu* vis-a-vis natural *Shorea robusta* forest and barren land. The results of this study can lead to formulation of workable strategy to improve the soil conditions within the given seasonal peculiarities to achieve higher biomass returns.

Material and Methods

This study was conducted in Compartment No. Ia of Domet block, Langha Forest Range, Mussoorie Forest Division for all plantations while in Compartment No. II a for *Shorea robusta* (Natural Sal). All the sites were in vicinity having similar slope, aspect, soil geology and biotic interference. Area under *Pinus roxburghii, Tectona grandis, Eucalyptus, Dalbergia sissoo, Acacia catechu*, Natural *Shorea robusta* and barren land was 0.15 ha, 0.16 ha, 1.17 ha, 3.02 ha, 0.63 ha, 0.50 ha and 0.09 ha, respectively. *Pinus roxburghii, Tectona grandis, Eucalyptus, Dalbergia sissoo* and *Acacia catechu* were planted in 1982.

Climatically, it is a tropical site, having mean annual rainfall of about 1600 mm. Maximum temperature varies from 22°C to

Fig. 1



Climatological data of Experimental Site

38°C while minimum temperature varies from 4°C to 25°C. Details of climatological data are presented in Fig. 1.

Three sampling points were selected under each plantation, barren land and natural *S. robusta* forest. Soil samples were collected from predetermined depths i.e. 0-10, 10-30, 30-60, 60-90, 90-120 and 120-150 cm with the help of auger. Pre-monsoon samples were collected in the month of March and post-monsoon samples in the month of October. These samples were collected for two years. Mean values have been used for resolving the trends. For vegetation study several numbers of 10 x 10 m quadrates were laid down under each plantation and measured the tree density. C.B.H. was measured with the help of tape and than converted into D.B.H. Crown area was measured with the help of tape and punchan crown meter.

All the samples were air dried and processed as per the standard procedure described by Jackson (1967). Organic carbon was estimated by oxidation method of Walkley (1946) and organic matter value were obtained by multiplying organic carbon values by 1.724.

Results and Discussion

Soil of this area was silty loam under *Pinus roxburghii* and *Dalbergia sissoo* while loamy sand under *Tectona grandis* and sandy loam under *Eucalyptus* throughout the soil profile. Under natural *Shorea robusta* and barren land, top layer was loamy sand while middle layer was loam. Under *Acacia catechu*, top layer was loam and middle layer was clay loam. Soils under all plantations were acidic in reaction upto 150cm depth. Under *Pinus roxburghii, Tectona grandis* and *Eucalyptus* it was mildly acidic (5.98 to 6.67) while under *Dalbergia sissoo, Acacia catechu*, natural *Shorea robusta* and barren land it was moderately acidic (4.65 to 5.97). Soils under all plantations were well supplied in Nitrogen (total N 0.018 to 0.11%; available N 0.0015 to 0.010%), Phosphorus (total P 0.0053 to 0.030%; available P 0.0017 to 0.0045%) and Potassium (total K 0.29 to 1.04%; available K 0.0021 to 0.041%).

Soil Organic Matter (SOM) status before monsoon under different plantations, natural *S. robusta* forest and barren land is shown in Table 1. Results revealed higher SOM under natural *S. robusta* in comparison to all plantations and least in the soils under barren land throughout the soil profile (except the sub-soil under *Eucalyptus* and *D. sissoo*). Soils under all plantations and natural forest are well supplied in organic matter especially upto 90 cm under *Pinus roxburghii, Tectona*

Table 1

Soil organic matter status under different plantations before monsoon

Soil depths (cm)	*P. roxburghii*	*T. grandis*	*Eucalyptus*	*D. sissoo*	*A. catechu*	Natural *S. robusta*	Barren-land
	(%)						
0-10	1.57	1.61	2.52	2.58	2.20	2.72	0.78
10-30	0.90	1.34	1.79	1.68	1.25	1.69	0.72
30-60	0.87	1.10	1.32	1.39	0.83	1.13	0.56
60-90	0.75	0.82	1.10	1.25	0.64	0.87	0.41
90-120	0.63	0.65	0.93	1.12	0.46	0.71	0.28
120-150	0.47	0.62	0.74	0.94	0.33	0.47	0.17
Corr. Coef. Depth vs Org. Matter content	-0.86	-0.96	-0.91	-0.86	-0.87	-0.89	-0.99

Table 2

Vegetation characteristics of different social forestry plantations at Langha Range

Plantations	Tree density (tree/ha)	dbh (cm/tree)	Crown area (m²/tree)	Crown cover (m²/ha)
P. roxburghii	992	19.67	18.08	17935
T. grandis	605	20.00	20.82	12596
Eucalyptus	928	21.04	23.76	22049
D. sissoo	850	15.11	16.16	13736
A. catechu	1119	13.88	27.74	31041
Natural *S. robusta*	473	41.94	75.67	35791
Barren Land		No Vegetation exists		

grandis, Acacia catechu and natural *Shorea robusta* while up to 150 cm under *Dalbergia sissoo* and *Eucalyptus*. It is obvious that the SOM was least under barren land due to no vegetation. In the absence of leaf litter there is not much decomposition and humification. Hosur and Dasog (1995) and Kumar *et al* (1994) have also reported similar findings. Due to the old natural *Shorea robusta* forest having crown area 75.67 m²/tree and dbh 41.94 cm/tree (Table 2) soils received higher annual litterfall perpetually than the plantations, hence soil supported by natural forest are rich in SOM as compared to soils supported by different plantations where the crown area varies from 16.16 to 27.74 m²/tree and dbh varies from 13.88 to 21.04 cm/tree (Table 2). The age of all plantations was 15 years only. In the early years the plantations, were unable to produce a sizable amount of litter of the floor. Fisher *et al.* (1975) also reported that an old field contains more SOM than an adjacent pine plantation, despite the fact that plantation annually returned more organic matter to the forest floor.

SOM content under all plantations, natural *S. robusta* and barren land showed inverse relationship with soil depth having significantly negative correlation of -0.86 and -0.98 under *Pinus roxburghii*, 0.96 and -0.85 under *Tectona grandis*, -0.91 and 0.90 under *Eucalyptus*, -0.86 and -0.91 under *Dalbergia sissoo*, -0.87 and -0.91 under *Acacia catechu*, -0.89 and -0.86 under natural *Shorea robusta* and -0.99 and -0.98 under barren land before monsoon and after monsoon respectively. This trend may be because of the decomposition of good amount of litter at surface as well as effective humification. Negative correlation of SOM with depth is also reported by Dhir (1967), Jha *et al.* (1984) and Gupta *et al.* (1991).

SOM content after monsoon under different plantations, natural *Shorea robusta* forest and barren land are shown in Table 3. It is evident from the data the SOM content was higher under *Eucalyptus* only in top (0-10 cm) but over all higher under the soils of natural *Shorea robusta* followed by *Eucalyptus, Dalbergia sissoo, Pinus roxburghii, Acacia catechu, Tectona grandis* and least in barren land. Soils were rich in organic matter under *Pinus roxburghii, Eucalyptus, Dalbergia sissoo*

Table 3

Soil organic matter status under different plantations after monsoon

Soil depths (cm)	*P. roxburghii*	*T. grandis*	*Eucalyptus*	*D. sissoo*	*A. catechu*	Natural *S. robusta*	Barren-land
	(%)						
0-10	1.98	2.00	3.30	2.50	2.76	2.74	0.93
10-30	1.68	1.24	2.25	1.82	1.77	2.31	0.72
30-60	1.42	0.92	1.74	1.48	1.31	1.64	0.63
60-90	1.22	0.49	1.27	1.15	0.85	1.31	0.51
90-120	0.90	0.62	1.12	1.01	0.59	1.27	0.37
120-150	0.77	0.47	0.92	0.90	0.50	1.37	0.20
Corr. Coef.	-0.98	-0.85	-0.90	-0.91	-0.91	-0.86	-0.98

Depth vs Org. Matter content

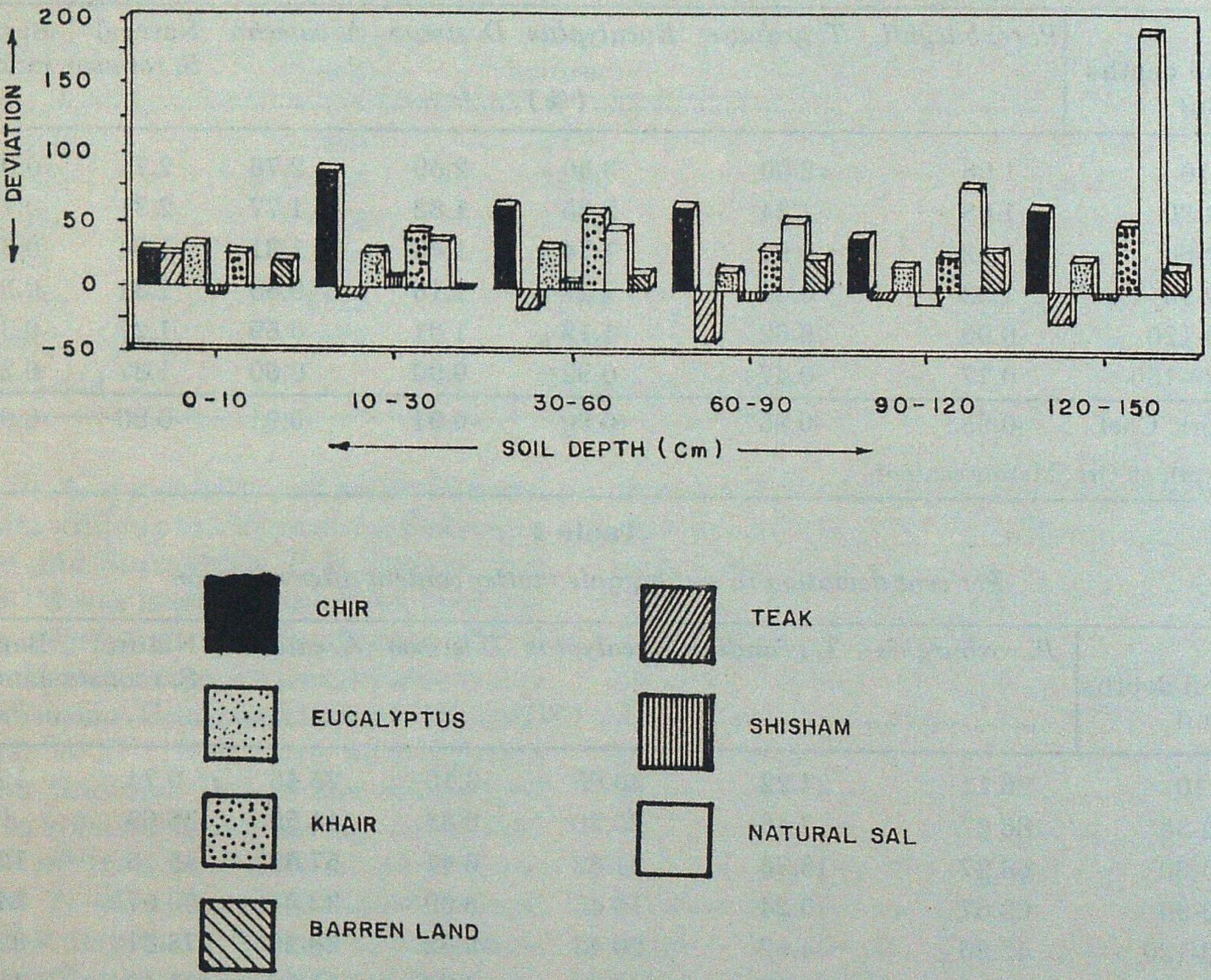
Table 4

Per cent deviation in soil organic matter content after monsoon

Soil depths (cm)	*P. roxburghii*	*T. grandis*	*Eucalyptus*	*D. sissoo*	*A. catechu*	Natural *S. robusta*	Barren-land
	(%)						
0-10	26.11	24.22	30.95	-3.10	25.45	0.74	19.23
10-30	86.67	-7.46	25.70	8.33	41.60	36.69	0.00
30-60	63.22	-16.36	31.82	6.47	57.83	45.13	12.50
60-90	62.67	-40.24	15.45	-8.00	32.81	50.57	24.39
90-120	42.86	-4.62	20.43	-9.82	28.26	78.87	32.14
120-150	63.83	-24.19	24.32	-4.26	51.52	191.49	17.65

and natural *Shorea robusta* forest up to the depth of 150 cm while upto 60 cm under *Tectona grandis* upto 90 cm under *Acacia catechu*. It is revealed from the data (Table 4) that in the soils under *Pinus roxburghii, Eucalyptus* and *Acacia catechu* plantations along with natural *Shorea robusta* and barren land SOM content increased after monsoon throughout the soil profile. Only under *Tectona grandis* below 10 cm and under *Dalbergia sissoo* in top 0-10 cm and below 60 cm depth SOM decreased after monsoon. It is generally known that considerable spatial and temporal variations exists in the availability of nutrients in the soil. Increase in SOM content after monsoon can be easily predicted because soil microorganism are more active under optimum moisture and temperature. These two conditions are more favourable during monsoon as compared to summer months. Maximum increase in SOM content after monsoon (191.49%) was observed below 120 cm depth under natural *Shorea robusta* because of higher frequency of root channels under natural forest of *Shorea robusta* and minimum increase (0%) was observed in 10-30 cm under barren land. Maximum decrease in SOM content after monsoon was (40.24%) recorded in

Fig. 2



Per cent deviation in Soil Organic Matter after monsoon
(in comparison to before monsoon)

60-90 cm depth under *Tectona grandis* and minimum decrease (3.10%) was in 0-10 cm under *Dalbergia sissoo*. Significant variation in the surface bulk density, per cent moisture and organic matter was also reported by Haines and Cleveland (1981) over the time during one year of study period in five forested sites.

Deviation in SOM after monsoon was less in top layer in comparison to subsoil below 10 cm under *Pinus roxburghii, Acacia catechu* and natural *Shorea robusta* while under *Eucalyptus* and barren land no such trend was noticed (Fig. 2). This is quite possible due to of humus differential leaching under these plantations. There was no clear trend of deviation observed within the profile under all plantations, natural *Shorea robusta* and barren land.

SUMMARY

A study was conducted in Langha Forest Range of Mussoorie Forest Division under 15 years old plantations of *Pinus roxburghii, Tectona grandis, Dalbergia sissoo, Eucalyptus, Acacia catechu* along with natural *Shorea robusta* forest and barren land to find out the status of soil organic matter. This study was conducted before and after monsoon to investigate the changes in SOM due to change of seasons. Before monsoon it was observed that SOM content was higher under natural *Shorea robusta* followed by *Dalbergia sissoo, Eucalyptus, Tectona grandis, Acacia catechu* and *Pinus roxburghii* plantations and least under barren land and after monsoon it was higher under *Eucalyptus* only in top (0-10 cm) layer but over all higher under the soils of natural *Shorea robusta* followed by *Eucalyptus, Dalbergia sissoo, Pinus roxburghii, Acacia catechu, Tectona grandis* and least under barren land. In general SOM was observed higher in post-monsoon in comparison to pre- monsoon period.

विभिन्न समाजवानिकी रोपवनों में मृदा की जैवतत्व स्थिति

एम०एन० झा, एम०के० गुप्त व बी०एम० डिमरी

सारांश

मृदा की जैवतत्व स्थिति का पता लगाने के लिए शाल के प्राकृतिक वन और बंजर भूमि को साथ लेकर चीढ़, सागौन, शीशम, *युकेलिप्टस* और खैर लगाए हुए 15 वर्षीय रोपवनों का एक अध्ययन मसूरी वनमण्डल के लांघा वन परिक्षेत्र में किया गया । यह अध्ययन मानसून से पूर्व और उसके पश्चात् मौसम बदलने से मृदा के जैवतत्वों में होने वाले परिवर्तनों का अन्वेषण करने के लिए किया गया । मानसून से पूर्व यह देखने में आया है कि जैव मृदा तत्वों की शाल प्राकृतिक वन में अधिकता थी जिसके पश्चात् क्रमशः शीशम, *युकेलिप्टस*, सागौन, खैर और चीड़ के रोपवन आते थे तथा सबसे कम जैवतत्व बंजरभूमि में थे तथा मानसून के पश्चात् उनकी मात्रा *युकेलिप्टस* में केवल ऊपर के (0 - 10 सेमी०) मृदा स्तर में अधिक पाई गई परन्तु समग्रतः यह प्राकृतिक शाल वन की मृदा में ही अधिक थे जिसके पश्चात् क्रमशः *युकेलिप्टस*, शीशम, चीड़, खैर और सागौन के रोपवन आते थे । सबसे कम वे बंजरभूमि में मिले । सामान्यतः कहा जाए जो मृदा के जैव तत्व मानसून पूर्व अवधि की तुलना में मानसूनोत्तर अवधि में अधिक मिलते पाए गए ।

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TRADE LIBERALISATION IN SANDALWOOD

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Introduction

Sandalwood (*Santalum album*) is probably one of the most valuable trees, with its heartwood fetching more than Rs. 4,00,000 to 5,00,000 per tonne. This species grows naturally and extensively in Karnataka, Tamil Nadu and Andhra Pradesh. It was also introduced in parts of Orissa, U.P. and M.P. with little success. It occurs in Southern Dry Deciduous and Thorn Forest types, either along with other species as "associate" or along farm bunds and fence of private holdings. Natural regeneration is spreading faster through birds due to fleshy fruits that it produces twice annually. *Santalum* sp. is also reported in Australia, Indonesia and New Zealand. Scented heartwood of Sandalwood tree that yields the famous Sandalwood oil was in great demand in European and Mid-Eastern countries for perfumery etc. and hence was exported since the time of Tipu Sultan or even earlier from South India. Due to its great importance and value at that time, it was declared as "Royal Tree" though clear definition of "Royal Tree" is not forthcoming in any records including in Indian Forest Act (IFA) and Karnataka Forest Act (KFA) 1963. However, the Sandalwood tree where ever found in Karnataka is the property of State Government. No one is allowed to buy, sell or trade except through the Forest Department. The major quantity of heartwood obtained out of dead and dying trees harvested, used to be allotted to Sandal Oil Factories located at Mysore and Shimoga, but now due to the declined production of Sandalwood oil in these factories, there is lot of accumulation of heartwood of Sandal in various depots of the Forest Department. Small quantities are being released on retail sale basis, and for temples, carving etc. Small consignments were also exported on trial basis by the Karnataka State Forest Industries Corporation.

Restriction on Trade

Sandalwood is a "Forest Produce" under Sec. 2(7)-a of KFA, 1963, whether found in or brought from a forest or not. Therefore the control of Sandalwood in transit is vested in the State Government (Sec. 50 - KFA), like any other forest produce listed under Sec. 7(a). It is not however listed under the definition of "Reserved Trees" vide Sec. 2(15), probably because of the special status already given to it in KFA. The IFA does not have any special provisions for Sandalwood but KFA 1963 has a separate Chapter X relating to Sandalwood. It is an exclusive property of State Government (Sec. 84); and under Sec. 85, the land holders are responsible for preservation (protection ?) of all Sandal trees grown thereon. If they fail to report any theft of or injury to Sandal trees, they are liable for penalty and to pay compensation to the State Government.

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The accused of any offence pertaining to Sandal trees on conviction will be liable for imprisonment upto 7 years with fine upto Rs. 25,000/-. Earlier days it had very good impact, but of late the same law has become disincentive to farmers. Such stringent rules have made people discourage the presence of Sandal trees in their holdings. They uproot the Sandal recruits and small seedlings to avoid responsibility and future penalty in the event of any offence. This has considerably reduced the population of Sandal trees in private holdings. Persons should also obtain license to store, sell or disintegrate Sandalwood or Sandalwood oil under Sec. 87. This has also discouraged entrepreneurs from taking up industries based on Sandalwood as raw material such as agarbatti, soaps, perfumery products etc. The Sandalwood definition under Sec. 1(18) of KFA includes even bark and leaves which have no monetary value, yet same restrictions or penalty are imposed, thereby further impeding the growing of Sandal trees by people.

Under Karnataka Forest Rules (KFR) 1969, Sec. 104, all owners have to declare the presence of Sandal trees in their land and renew every five years to include all new recruits. The owner will have right to bonus on harvesting, only if he has declared them to the local Division Forest Officer. This in fact binds him to protect the Sandal trees and failing which becomes liable for penalty, punishment as well as compensation. Therefore one thinks that it is safer to remove them and destroy as and when it regenerates in his land. There is also an elaborate procedure to get bonus from the Forest Department. Though the bonus is 75% of the value, deducting the working and handling cost by the Forest Department, in practise to speed up the issue, the owner himself helps to uproot the tree and transport to the nearest depot and waits for the bonus. It takes several months before the material is converted and assessed for the payment of bonus. There are lot of complaints that the amount one gets finally is far less than estimated or assured, due to careless and bad conversion. Even if the bonus is declared, the payment by the Divisional Office comes only after sufficient allotment for the purpose is received from the Government, which sometimes takes more than one or two financial years. By this time the owner might have paid several visits to the Divisional Office expecting payment and returned disappointed. Though a portion (50%) of the estimated value of the Sandalwood extracted should be given on the spot or immediately to the owner, it is also not working to the satisfaction of the owner. Normally dead and dying trees are harvested by the Forest Department, but if one wants to remove one or two living trees to make room for buildings, plantings or any other purpose, then it takes months together by the Forest Department delaying the activities further. All these procedures, rules, delays and over enthusiasm of some bureaucrats and conservationists have put a curse on the existence of Sandal trees in private lands. Even if one or two mature Sandal trees are available in any private lands, these are always under threat of illicit felling or smuggling leading to harassment of owners by the Police or Forest Department.

Liberalised Trade

Sandal tree is the only tree species reeling under such severe restrictions. Catechu (*Acacia catechu*) tree and Rosewood (*Dalbergia latifolia*) tree also have some regulations under KFR 1969. The nationalised sale of Rosewood in

Karnataka has also come to criticism due to elaborate sale procedures and delay. Many have left the fallen or dead Rosewood trees to decay in their lands than to salvage for money due to these procedures. Many have made furniture out of it thus depriving its best utilisation and revenue to Government. At present any wood is valuable. One m^3 of good quality Rosewood will fetch Rs. 1,00,000 or more. It has been assured by some Tree Companies that an investment of Rs. 5,000/- would fetch about Rs. 5,00,000 out of Teak (*Tectona grandis*) in 20 years, which is more than the value expected out of Sandalwood tree. Then why this restriction on Sandal trees only that discourages its growing ? Each State has its own rules and regulations on Sandal trees. In Kerala, though Sandal trees are not available in appreciable quantities, several small scale Sandalwood distilleries have come up along the border of Karnataka and Tamil Nadu and most of the smuggled billets reach there. The Sandalwood Advisory Committee formed by the Government of India could not make any positive suggestions to satisfy all the member States. The reduced intake by the Sandal oil factories of Mysore and Shimoga has accumulated large stock of heartwood of Sandal in the Sandal kotis of the Forest Department of Karnataka. It has locked up considerable revenue of the government. This has also caused anxiety in fire protection during storage leading to payment of huge insurance premiums annually. The smuggling or illicit cutting of Sandal trees are still rampant in spite of all these restrictions and has not in any way contributed to the preservation of Sandal trees. Leaves are highly palatable, particularly goat enjoy it. Lopping of Sandal trees by graziers continue in Government lands. The rules and regulations are frequently flouted than adhered to, due to the laxity on the part of the controlling authorities. The collection of dry fuelwood on head loads and free grazing of cattle permitted by the Government in Reserve Forests and the ongoing encroachments in Government lands including Reserve Forests, leave little scope for any restrictions or control and thus the provisions remain on paper.

Wood of many species has become more expensive but we cannot put all of them under such rigid restrictions. The argument that once the rules are amended and relaxed for Sandalwood, there will be large scale exploitation of this species leading to wiping out of the entire population, is baseless. If that is so, this should have happened to Teak and Rosewood species already. On the contrary, many are investing in Teak plantations offered by companies. In this period of liberalisation in all sectors, it is necessary to review these restrictions and amend the Act and Rules to bring in free trade in Sandalwood also. People should be able to possess and sell Sandalwood to anyone who offers good price. The Forest Department should make arrangements to protect their own forest produce without imposing any restrictions on others' material. This will encourage people to grow more and more Sandal trees because of the value it fetches at present. People have to grow other tree species also as "host plants" and will activate tree growing to a large extent. This would indirectly help in bringing more tree population into farm lands thus improving the ecology and environment of the locality. Sandal trees are not very specific to soil and climatic conditions and comes up well, faster and easily in many soil types and climates. Hence growing Sandal trees will be attractive and forms a supplementary income to people. Once the population of

Sandal tree increases and the market rate stabilises, then there will not be much anxiety of theft or smuggling because people themselves will protect their valuable property having Sandal trees. The price may ultimately come down making it less attractive for smugglers. The restrictions imposed on "Royal Tree" more than 200 years ago, when the demand was more and the then rulers wanted a monopoly, deserve to be relaxed now introducing free trade like any other valuable tree species or forest produce. To suit the present day needs of employment generation and environmental protection the ancient rules should be amended. The Karnataka Forest Department has submitted proposals recommending amendment of the old rules and once it is approved by government, Sandal will have better prospects. Supplying Sandalwood to Sandal oil factories at throwaway prices of Rs. 1,30,000 per tonne also requires rethinking.

Free trade will encourage people to grow Sandal trees and even Tree Companies may come forward to raise Sandal trees like the present Teak, *Populus* and *Acacia mangium*. Tamil Nadu has liberalised the rules to allow farmers to grow Sandal wood and sell it to Forest Department when harvested at a reasonable price.

SUMMARY

Sandalwood (*Santalum album*) naturally occurs extensively in Southern States of India such as Karnataka, Tamil Nadu and Andhra Pradesh. It had export market from the period of Tipu Sultan or earlier for European and Mid-Eastern Countries and was therefore declared as "Royal Tree" in Karnataka. Special chapter exists in Karnataka Forest Act 1963 and Karnataka Forest Rules 1969, though nothing is mentioned in Indian Forest Act. Sandalwood is a Government property where ever it is found in Karnataka and therefore there are strict rules and regulations for its protection in and harvest from private lands; for its movement, trade and use. These are a deterrent for its existence and growth. People destroy its regeneration if found in their holdings. The declaration of bonus upto 75% of its value has not also encouraged its growing due to its inherent procedures and delays. There is a need for, rethinking and liberalising the existing rules, regulations and restrictions. The payment of bonus also needs simplification.

चन्दनकाष्ठ व्यापार में उदारता लाना

कोडिर ए० कुशलप्पा

सारांश

चन्दनकाष्ठ (*सेण्टेलम एल्बम*) स्वभावत: भारत के दक्षिण राज्यों जैसे कर्णाटक, तमिलनाडु और आंध्र प्रदेश में ही विस्तार से पाया जाता है । टीपू सुल्तान के समय अथवा इससे भी पहले से ही योरोपीय और मध्यपूर्वी देशों से इसका निर्यात व्यापार होता रहा है और इसीलिए कर्णाटक में इसे राजकीय वृक्ष घोषित पर दिया गया था । कर्णाटक वन अधिनियम, 1963 और कर्णाटक वन नियम, 1969 में एक विशेष अध्याय भी इसके विषय में है यद्पि भारतीय वन अधिनियम में इस पर कुछ भी नहीं कहा गया है । कर्णाटक में जहाँ भी यह मिलता है वहाँ इसे सरकारी सम्पत्ति माना गया है और निजी भूमियों पर इसकी रक्षा और कटाई, लाने ले जाने, व्यापार और उपयोग करने पर कड़े कानून बनाए हुए हैं । ये कानून इसके बने रहने और बढ़ने में अवरोध हैं । यदि अपनी जमीन में यह दिखाई दे जाए तो लोगबाग पुनरुत्पादन को नष्ट कर देते हैं । इसके मूल्य के 75% तक बोनस दिया जाने की घोषणा ने निर्धारित प्रविधियों और उनके पूरा करने में लगने वाली देरी के कारण इसकी वृद्धि प्रोत्साहित नहीं की है । अत: इस बारे में पुर्नविचार करने और वर्तमान नियमों, विनियमों और प्रतिबंधों को उदार बनाने की आवश्यकता है । बोनस भुगतान को भी सरल बनाया जाना चाहिए ।

PARTICIPATORY FOREST MANAGEMENT TO MEET BASIC NEEDS OF FOREST DEPENDENT COMMUNITIES

PRATIMA* AND S.S. JATTAN**

Introduction

Degradation of forests in India is a continuing process and degraded forests account for about one-third of the total forest area. Besides very heavy pressure of human and livestock population, alienation of rural communities from forest resource protection and management is an important factor responsible for degradation of forests. In the past, local communities enjoyed free access to the forests. With the bringing of forests under government control and consequent reservation of forests permitting only specified usufructory concessions, local communities were denied access to forest resources. Forest reservation policy came in conflict with the interests of local communities dependent on these forests to meet their basic needs of forest products. The forests were managed as government property in larger national interests as provided for in the National Forest Policy, 1952 (Anon., 1952) which stated that the use of forests by village communities in their neighbourhood should in no event be permitted at the cost of national interests. Such policy of managing forests only in larger national interests, overlooking the basic needs of local communities did not succeed and forests were degraded as a result of over use. Forest Department (FD) could not effectively protect the forests whose degradation continued.

Forest conservation necessitated active participation of local communities. The National Forest Policy, 1988 (Anon., 1988) accordingly provided for creating a massive people's movement for the conservation of forest resources with the involvement of women who suffer the most as a result of forest degradation. Guidelines were accordingly issued by Government of India in June, 1990 to involve local communities in the protection and rehabilitation of degraded forests. This approach is commonly referred to as Joint Forest Management (JFM).

Joint Forest Management Philosophy

Traditionally, the FD managed the forests by regulating the rights and concessions of the local communities. The FD maintained a distance from the people and asserted its authority. The restrictions on the use of forests by local communities in the interest of forest conservancy resulted in conflicts between the FD and the local people. As the ownership and management of forests rested with the FD, the local people remained interested only in the exploitation of forest resources and took no interest in their regeneration and sustainable development.

The National Commission on Agriculture (Anon., 1976) reviewed the position and its recommendations provided for the involvement of local people in social forestry plantations and supported the realisation for involving the people in the protection and management of forests. Later, the National Forest Policy, 1988 (Anon., 1988) emphasized that domestic requirements of the tribals and other poor people living within and near the forests for fuelwood, fodder, NWFP and construction timber should be the first charge on forest produce and the holders of customary rights and concessions in forest areas should be motivated to identify themselves with the protection and development of forest from which they derive benefits. In pursuance to the National Forest Policy, the Ministry of Environment and Forests, Government of India issued guidelines in June 1990 for adopting JFM approach for the protection and rehabilitation of degraded forests. Following the Government of India guidelines, some States issued necessary orders to introduce JFM (Anon., 1993). JFM thus got the necessary policy and political support.

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JFM is a concept under which FD and village community jointly protect and manage the forest. The starting point of JFM has to be the realization of the need of JFM both by the FD and the local people. Generally, the scarcity of forest products such as fuelwood, fodder etc. as a result of degradation of forests on which the local communities depended, forces the people to think of steps for the protection and improvement of degraded forests. The people are usually reluctant to participate in JFM where sufficient forest areas are still available to meet their requirements. On the part of FD, the problems in protecting forests without the help of local people make the FD staff realize the need of JFM. The JFM programme succeeds where the initiative comes from the people's side and it usually fails where it is forced from FD side as a government driven and target-oriented programme.

Scope and Objectives of JFM

The JFM approach has been adopted to protect and rehabilitate only the degraded forests and has not been extended to non-degraded forest areas. Degraded forests for the purpose are, however, somewhat loosely defined. Most of the forests in India suffer from some form of degradation. The Forest Survey of India (Anon., 1991) classifies forests as dense forests (crown density 40% and above), open forests (crown density 10 to <40%) and scrub (crown density <10%). Generally speaking, the open and scrub forest areas are regarded as degraded. In some States, the forests with less than 25% crown density are included in degraded category of forests for JFM. In West Bengal, the priority areas for JFM include open forest and scrub with viable root stock (Bardhan Roy, nd).

In view of extensive degraded forests and limited resources available for their rehabilitation, the approach is to bring under JFM heavily degraded forests and then gradually cover the less degraded areas (Palit, 1992). With this approach, the degradation process continues and rehabilitation of degraded forests may be an unending process. It may be better to extend a suitable form of JFM to non-degraded forests also so that the same are not degraded. The hesitation of the FD in extending JFM to well stocked forests is because of the likely fall in forest revenue; protection of such areas not being very difficult in view of their location generally away from habitations, and the difficulties in assigning reserved forests free from rights and concessions to different villages under JFM. It is also argued that the main objective of JFM should be the meeting of local people's requirements for forest products instead of sharing the revenue generated from forests and that management of well stocked high forests will be more suited for timber production to meet national demand than for meeting fuelwood, fodder and small timer requirements of the people. Introduction of JFM in well stocked forests for the protection and development of non-wood forest products (NWFPs) may, however, be a good starting point to prevent degradation of such forests (Singh, 1996).

The main objective of JFM as stated in the resolutions issued by different State governments (Anon., 1993) is the protection and rehabilitation of degraded forests with the involvement of local people. The National Forest Policy, 1988 (Anon., 1988) provided that the requirements of forest products of the tribals and other villagers living in and near the forests are to be treated as the first charge on forest produce. It implies that meeting the requirements of the local people consistent with the productive capacity of forests should be the main objective of JFM. Besides meeting the forests products requirements of the local people, additional income generation needs to be recognized as very important to sustain the interest in JFM of the local people who are generally very poor. Additional income generation can be achieved by increasing employment opportunities and by establishing cottage industries for value addition to the forest products obtained by the beneficiaries under JFM. The existing provisions of the JFM do not very clearly and sufficiently emphasize the need of meeting the local people's requirements. The management practices under JFM have not been changed to increase the yield of products needed to meet people's requirements. The approach is to share whatever is produced from forests under the JFM and, in many cases, the burden of meeting the balance requirements is transferred to the adjoining forests whose degradation is accelerated.

Establishment of Village Level Organisation

In order to establish partnership between FD and village community, a village level organization commonly called Village Forest Committee (VFC) is constituted. FD initiates the dialogue to constitute VFC. This work is very much facilitated by NGOs having good rapport with village community. Generally, majority of the households in the village become members of VFPC. The representation of women in VFPC is ensured by having two adult members (one male and one female) from each household. Making each household a member of the VFC is preferred. In some States, however, VFC is constituted if majority of the households in a village agree to constitute the VFC. In the latter case, exclusion of the right holders from the share of usufructs under JFM is very difficult and may lead to litigation and avoidable complications. When the degraded forests start yielding some income, conflicts increase between contending resource users.

The VFC could either be a society registered with FD or a cooperative society. In some States, Tribal Cooperative Societies or Tree Growers Cooperative Societies also function as VFCs. It is essential to ensure apolitical character of the VFCs. Some political support to the VFC at village level is, however, necessary for conflict resolution and to apprehend the offenders as VFCs have no legal authority in this regard. Such a support is usually provided by including a Panchayat member in the VFC. In order to control the working of VFC, the FD usually prefers the VFC to be registered with it. Debate still continues regarding the most appropriate arrangement for constituting VFCs.

The VFC may be constituted for each village or a group of villages; the former is generally considered better. In cases where the villagers of more than one village have been enjoying the rights and concessions in a forest, constitution of VFC for the concerned group of villages is attempted. Because of the heterogeneity among the villages, constitution of VFC for each village may be desirable by clearly demarcating the forest area for each village.

Planning and Implementation of JFM

Each VFC constitutes a managing committee consisting of members elected from general body and ex-officio members representing concerned government departments at village level and with local Forester as the member secretary. The managing committee is responsible to implement the decisions of general body with regard to the execution of JFM works in partnership with FD.

The degraded forest area abutting a village and being used by the village community to meet its requirements is identified and taken up for JFM. Forest resource allocation for each village is a difficult task and is attended to with utmost care. Resource allocation conflicts are best resolved by village communities themselves.

Memorandum of Understanding (MoU) is signed between FD and managing committee clearly specifying the duties and responsibilities of both parties. Entitlement of VFC members to the share in forest produce is subject to the fulfilment of conditions of MoU.

Joint management of the forest identified for the purpose is done according to the microplan prepared by involving VFC members. In an ideal situation, the VFC would identify the needs of its members and develop forest management plans which should then be used to determine budgetary allocations and management activities at a decentralised level (Campbell, 1992). The prescriptions of the Working Plan operative in the Forest Division are superseded by the management plan in respect of the concerned forest.

VFC members share the protection work for which different systems have been evolved to suit socio-economic and cultural backgrounds of village communities. Normally, the responsibility of protection is shared equally by VFPC members. Special protection units become necessary to counter organised smuggling gangs. Where women from adjoining villages are the offenders, women of the village form protection units because men cannot grapple with and apprehend women in village societies. The VFCs have, however, no legal power to apprehend offenders. The experience of JFM in the country shows that VFCs are capable of affording effective protection which was not possible by FD alone. About 1.50 million ha forest area is already being protected by VFCs (Agarwal and Saigal, 1996).

Benefits of JFM to VFC Members

The VFC members are normally entitled to collect all Non-Wood Forest Products (NWFPs) from JFM areas and to receive a share in the final harvest or in its net sale proceeds, the quantum of which varies in different States and under different conditions. The quantities of NWFPs collected depend on the area and productivity of the forest and the intensity of collection. Generally speaking, the value of NWFP collected is more than the share of sale proceeds of timber (Malhotra *et al.*, 1992). The NWFPs are important because they start yielding income from the very first year while the income from timber is available only at the end of the rotation.

The income to be generated under JFM should be sizeable. The VFC members may rightly expect that the return they get is at least commensurate with their labour input in JFM. They are required to invest time in JFM activities such as attending meetings to decide about the protection and management of a particular forest under JFM programme, participation in microplanning exercises, patrolling to protect the forest and activities concerning conflict resolution and apprehending the offenders etc. No case studies have, however, been conducted to determine the time spent by the villagers on different JFM activities. Serious efforts are necessary to improve the monetary benefits to sustain active participation of the villagers in JFM.

The mechanisms of sharing the usufructs among the FD and the VFC members are laid down in government orders on JFM which need to be very clear and specific so that VFC members may not have any doubts with regard to expected benefits. Such provisions as "the benefits may be shared as may be decided by the Government" create suspicion in the minds of the people.

Experiences of JFM

The JFM approach is in the process of evolution. The experiences gained are many and some of the important ones are the following :

(i) The commitment of the FD staff is the most crucial factor for the success of JFM which necessitates reorientation of FD's role. The programme has succeeded only where FD staff could be reoriented and trained to handle this new responsibility.

(ii) The VFCs function well in villages with homogeneous social structure and problems are experienced where village community is divided on religious, caste or other considerations.

(iii) The VFCs formed for each village are more successful than those formed for group of villages because of inter-village conflicts with regard to resource use.

(iv) Production and availability of NWFPs as soon as possible from JFM areas to meet people's requirements and also to augment their income is important for the success of the programme as the people cannot wait for long periods to benefit from the sale of timber at the end of rotation when the regenerated forest or plantation will be harvested.

(v) Additional employment generation to augment the income of the local people is a very important consideration to create and sustain the interest of the people in the programme. It has been the experience that the initial enthusiasm of participation in the programme disappears with the decrease in employment opportunities in subsequent years.

(vi) Apolitical character of the VFCs helps in their proper functioning and every effort should be made to maintain the same.

(vii) Decision making with regard to the protection and management of JFM areas should rest with the VFC and not with the FD.

(viii) Gradual evolution of appropriate village level institution needs to be allowed for JFM instead of imposing the same by FD on lines laid down in the government order. Target oriented approach for the formation of VFCs does not work. The programme often runs into problems when VFCs are sought to be formed according to the targets fixed without making adequate ground preparation.

(ix) Constant touch and dialogue between the FD and VFC are necessary to resolve problems and to strengthen confidence necessary to sustain partnership in JFM. With the constitution of VFC and the finalisation of management plan, the work is only begun whose continuous follow up is necessary.

(x) Protection and regeneration of forests under JFM cannot be viewed in isolation, but should form an integrated part of holistic use of village land resources.

(xi) Natural regeneration of the degraded forests is cheaper than raising plantations. It is more beneficial to the VFC members also when the net sale proceeds, after deducting the expenditure, are to be shared. With natural regeneration, the cost of planting is reduced and more VFCs can benefit from the limited funds available.

(xii) The approach of providing special staff for JFM works does not work. It is better to entrust this work to the existing territorial staff.

Future Approach

In view of the experience gained, the following points may be of help in further improving the success of JFM :

(i) The JFM programme may be extended to better stocked forests also. The first step in this direction could be the involvement of the people in the protection and management of NWFPs and share in the timber produced may be considered later.

(ii) The government orders on JFM should be very clear with regard to responsibilities of the FD and the VFC and about sharing of the usufructs and other benefits. Who will gain and how much should be very clearly provided for.

(iii) In order to ensure equitable distribution of the usufructs obtainable from JFM areas, right of sale of surplus produce within the village may be provided.

(iv) The NWFPs should be accorded the highest priority in JFM programme as these will ensure quicker returns, greater employment and enhanced income for the weaker sections in which the rich may not be able to extract greater advantage than the poor.

(v) Appropriate silvicultural systems to maximise benefits from multiple use management will have to be developed to replace traditional silvicultural systems concentrating on timber production. Sustainability of the silvicultural systems will have to be ensured as the management of JFM forests under short rotations will result in considerable nutrient drain from the sites.

(vi) Reorientation and training of the FD staff in JFM approach is the most crucial input needed to make this programme a success. Frequent transfers of the staff result in wastage of training efforts and have to be avoided.

(vii) JFM training should be started in the forest training schools so that the new entrants are exposed to this new approach before entering the service.

(viii) Mechanisms need to be evolved to make JFM a self-sustaining activity within as short a period as possible by ensuring financial viability of VFCs.

(ix) The structure of the FD needs reorganisation to make the FD responsive to its new role in JFM.

(x) Development of appropriate management practices for JFM will require a strong research support not only on matters concerning silviculture and utilization, but also on relevant socio-economic aspects.

SUMMARY

In pursuance of the National Forest Policy, 1988 provision to create a massive people's movement for the conservation of forest resources, Joint Forest Management (JFM) approach has been adopted in the country to protect and rehabilitate the degraded forests. The paper analyses the working of JFM and summarises the experience gained. Based on the past experience, suggestions are made to improve the implementation of JFM.

वन आश्रित समुदायों की आधारभूत आवश्यकताएँ पूरी करने के लिए भागीदारी वन प्रबन्ध करना

प्रतिमा व एस०एस० जत्तन

सारांश

राष्ट्रीय वन नीति, 1988 का अनुसरण करते हुए देश के व्याहसित वनों की रक्षा और उनका पुनरुद्धार करने के लिए संयुक्त वन प्रबन्ध दृष्टि अपनाते हुए वन संसाधनों के संरक्षणार्थ एक विशाल जन आंदोलन खड़ा करने का प्रावधान किया गया है । इस अभिपत्र में संयुक्त वन प्रबन्ध के कार्य संचालन का विश्लेषण किया गया है तथा उससे मिले अनुभवों का सारांश बताया गया है । पिछले अनुभवों के आधार पर संयुक्त वन प्रबन्ध की क्रियान्विति में सुधार के सुझाव भी दिए गए हैं ।

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EFFECT OF VARIOUS CHEMICALS ON SHORT SEQUENCE DEINKING OF WASTE PAPER AND ITS PILOT PLANT TRIALS

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Introduction

Due to acute shortage of conventional raw materials and ecological consciousness, Indian paper industry has been forced to search alternative fibre resources to meet the increasing demand of paper. As per an estimate, by the end of century, India would be requiring 4.37 million tonnes (MT) paper and paper board, 1.1 MT newsprint and 0.218 MT rayon grade pulp per annum, requiring about 12.16 MT of fibrous raw materials (Kale, 1995). Further, the studies conducted by Kale (1995) revealed that the use of recycled fibres is increasing and it would be 1.78 MT by the end of the century. Similar is the world wide trend (Fergusan, 1992, a,b; Higgins, 1992).

Indigenous waste paper is to be considered second grade as compared to imported due to short fibre furnish. Poor collection practices further makes the job tedious (Bharti and Rao, 1986; Harichandan and Mishra, 1986; Jain, 1986; Kar *et al.*, 1986; Raghuveer *et al*, 1986; Orgill, 1986; Thusu *et al*, 1990). However, in recent past various methods for recycling of inferior quality waste paper has been developed and further modification are in progress. (Peter, 1994; Shrinath and Szewczak, 1991; Lorren, 1992). In present investigation, Short Sequence Deinking (SSD) or pulper deinking, a potential deinking process applying considerably lower chemical energy, was studied.

Material and Methods

Raw materials used : Office waste, computer waste, magazines and newsprint were collected from the library of I.C.F.R.E., Dehra Dun. Clips, stapler and pins were screened out manually.

Short Sequence Deinking : Four samples viz : computer waste, office waste, magazines and newsprint were disintegrated in laboratory hydrapulper, separately for 10 minutes at ambient temperature and 8% consistency. After 10 minutes, steam was injected into hydrapulper to raise the temperature upto 70°C and deinking chemicals were added. Office and computer wastes were cooked using 3% sodium hydroxide for 30 minutes while magazines and newsprint were cooked for 45 minutes, separately using 1.5% of sodium hydroxide and 2% detergent and 1.5% sodium carbonate and 2% detergent. 8% consistency was maintained in both the cases. After deinking, the pulps were washed thoroughly with water by pulp, diluting and thickening.

Each deinked pulp, thus obtained was beaten in a Lampen mill to a freeness of 250 ± 25 (ml) CSF. Hand sheets of about 65±2 gsm were made on Standard British Sheet making machine, air dried, conditioned at 27 ± 1°C and 65 ± 2% relative humidity and tested for various properties.

Bleaching of deinked pulp : To improve the brightness, each pulp was bleached. Deinked pulp from computer and office waste (separately) were bleached with 2% available chlorine using Calcium hypochlorite at 40°C and 8% consistency for 40 minutes. pH 9-10 was maintained throughout bleaching. Deinked pulp of magazines and newsprint was bleached with 1.2% hydrogen peroxide, 5.0% sodium silicate as buffering agent and 0.5% magnesium sulphate as chelating agent. Bleaching was carried out at 70°C and 8% consistency for one hour pH during bleaching was maintained at 9.0±0.5.

The bleached samples were washed thoroughly with fresh water. Each pulp sample was beaten, sheets were made air dried, conditioned and tested as in the case of unbleached pulps. Pulp yield, strength properties and brightness are recorded in Table 1 and 2.

Pilot Plant trial of waste papers : 700 kg of old mixed waste papers and 700 kg of old magazines and periodicals were soaked, separately, in water at 8% consistency in pilot plant hydrapulper and disintegrated for two hours without chemical addition. Steam was injected into hydrapulper, simultaneously, to raise the temperature to 70°C. Deinking chemicals, sodium hydroxide (1.5%) followed by sodium silicate (3%) were added to complete distringated/ fibrised waste papers and cooked for another one hour at 70°C with occasional stirring. After one hour of cooking, magnesium sulphate (0.5%) and chelating agent (0.25%) followed by hydrogen peroxide (1.0%) was added to bleach the deinked pulp. Bleaching was carried out for one hour at 70°C with occasional stirring. Bleached pulp yield was 85.87% and 79.59% for old mixed papers and old magazines and periodicals, respectively.

Bleached pulps were blown in blown tank, processed through a coarse flat screen followed by send table, washed over Kamyr filter and transferred to a beater.

Stock preparation and paper making on pilot plant : Sizing chemicals were added to the beater loaded with screened and washed pulp. Old mixed waste papers and old magazines and periodicals were processed, separately, in beater for 30 minutes without placing load on the beater roll. Writing and printing paper possessing adequate strength properties and brightness was made on Fourdrinier machine. Runnability of paper on paper machine was satisfactory in both the cases. Both the papers were subjected to aging by keeping the papers at 80°C for four hours.

Results and Discussion

Effect of deinking and bleaching chemicals on pulp yield : Data recorded in (Table 1) revealed that after simple disintegration in water the pulp yield was highest for computer waste paper (86.94%) followed by office waste (83.72%), magazines (83.60%) and lowest for newsprint (80.30%). Lower pulp yield for newsprint may be attributed to the loss of higher percentage of fines during washing as newsprint contains higher percentage of mechanical pulp as compared to others. On deinking, pulp yield was further decreased by 5 to 8%. On bleaching further shrinkage in pulp yield (2-5%) was observed.

Table 1

Pulp yield before and after deinking chemical addition and after bleaching

Sample Code	Name of waste paper	Pulp yield after disintegration	Chemical added			Unbleached pulp yield after chemical addition (%)	Bleached Pulp yield (%)
			NaOH (%)	Na_2CO_3 (%)	Detergent (%)		
1.	Computer waste paper	86.94	3.0	-	-	79.03	75.29
2.	Office waste paper	83.72	3.0	-	-	77.00	72.08
3.	Magazines	83.60	1.5	-	2.0	74.82	72.01
3a.	Magazines	83.60	-	1.5	2.0	76.04	72.26
4.	Newsprints	80.50	1.5	-	2.0	72.06	68.42
4a.	Newsprints	80.50	-	1.5	2.0	75.40	72.53

Table 2

Strength and optical properties of unbleached and bleached pulps sheets

Sample code	Tensile index (Nm/g)		Burst index ($kPam^2/g$)		Tear index (mNm^2/g)		Brightness ISO		Yellowness (%)		Opacity (%)	
	UNB	BL	UNB	BL	UNB	BL	UNB	BL	UNB	BL	UNB	BL
1. Computer waste paper	28.17	25.25	1.69	1.46	6.47	5.68	63.69	71.51	6.45	9.26	96.22	89.48
2. Office waste paper	21.81	15.87	1.26	0.85	5.52	4.91	62.53	72.09	3.76	5.98	94.79	86.11
3. Magazines	21.88	21.95	1.03	0.90	3.03	2.91	54.19	61.94	11.32	8.71	95.75	92.34
3a. -do-	21.20	24.50	1.03	1.10	3.03	2.77	52.77	59.03	11.66	9.23	97.13	93.35
4. Newsprints	19.19	22.06	1.07	1.27	5.27	5.14	41.76	42.62	17.88	25.70	99.20	99.04
4a. -do-	19.38	20.27	1.13	1.11	5.56	5.21	46.68	52.26	15.23	18.66	98.83	98.04

UNB - Un-Bleached Pulp, BL - Bleached Pulp, Sl. No. corresponds to Table 1.

Effect of deinking and bleaching chemicals on properties of pulp sheets : From Table 2 it can be observed that tensile index Nm/g of computer and office waste of unbleached pulp was 28.17 and 21.01 Nm/g and for bleached pulp it was 25.25 and 15.87 Nm/g respectively. Similarly, tensile index of unbleached Na_2CO_3 treated magazines pulp was 21.20 Nm/g and for NaOH treated pulp it was 21.88 Nm/g. In the case of Na_2CO_3 unbleached pulp from newsprint, the tensile index was 19.38 and for NaOH treated pulp it was 19.19 Nm/g. On H_2O_2, bleaching the tensile index of pulp obtained from magazines and treated with Na_2CO_3 increased from 21.20 to 24.50 Nm/g while tensile index of Na_2CO_3 treated bleached pulp slightly decreased when compared with NaOH treated bleached newsprints. It was observed that burst index kPam^2/g of unbleached office and computer waste was 1.26 and 1.69 kPam^2/g and decreased to 0.85 and 1.46 kPam^2/g, respectively, after hypochlorite bleaching. Burst index was also decreased slightly after H_2O_2 bleaching except in case of NaOH treated newsprints where the burst index was improved from 1.07 for unbleached to 1.27 kPam^2/g for bleached pulp.

Tear index mNm^2/g of unbleached office and computer waste pulp was 5.52 and 6.47 mNm^2/g which was decreased to 4.91 and 5.68 mNm^2/g respectively, after hypochlorite bleaching. Tear index of unbleached Na_2CO_3 treated pulp was slightly higher (5.56 mNm^2/g) than NaOH treated unbleached newsprints pulp (5.27 mNm^2/g) and on bleaching with H_2O_2 a slight drop in tear index was observed for both the pulps. Tear index in both the cases of unbleached magazines pulp was the same (3.03 mNm^2/g) and decreased marginally on bleaching.

Table 3

Stock preparation conditions, Paper making parameters and strength properties of writing and printing paper

Parameters	Old mixed waste papers	Old Magazines & Periodicals
Consistency in be	6.00	6.00
Freeness of pulp ml (ml) C.S.F.	160	170
Rosin on o.d. pulp basis (%)	2.00	2.00
Alum on o.d. pulp basis (%)	6.00	6.00
Freeness of pulp after chemical addition (ml) C.S.F.	120	130
Consistency of pulp in head box (%)	0.50	0.50
pH of pulp suspension in head box	5.50	5.50
Machine speed (ft/minute)	110	110
Basis weight (gsm)	60±2	60±2
Burst index (kPam^2/g)		
Before aging	1.13	2.89
After aging	1.06	2.05
Tensile index (Nmg)		
Machine direction		
Before aging	27.54	32.15
After aging	26.25	31.05
Cross direction		
Before aging	18.16	2.45
After aging	17.76	21.2
Tear index (mNm^2/g)		
Machine direction		
Before aging	1.58	2.98
After aging	1.34	2.45
Cross direction		
Before aging	1.45	2.45
After aging	1.41	2.15
Brightness, ISO (%)		
Before bleaching	50.38	65.71
After bleaching	63.05	77.55

Effect of chemicals on the optical properties of unbleached and bleached pulp sheets : Result recorded in Table 2 reflected that bleached pulps obtained from office waste and computer waste possessed good optical properties. Brightness of Na_2CO_3 and NaOH treated newsprints unbleached and bleached pulp sheets varied from 46.60-52.20% ISO and 41.76-42.62% ISO, respectively. While in case of pulp from magazines, brightness varied from 52.77-59.06% ISO and 54.14-61-94%, respectively, for unbleached and bleached pulps. In case of pulp from magazines, yellowness was lower than that of newsprints. However, the capacity of pulp obtained from newsprints was higher as compared to the pulps obtained from magazines, computer and office waste due to higher amount of mechanical/semi-chemical pulp.

On Pilot Plant, the pulp yield of old mixed waste paper was 85.87% while old magazines and periodicals yielded 79.59% pulp. This may be attributed to the loss of higher amount of fines during washing as old magazines paper and periodicals contain higher percentage of mechanical pulp as compared to old mixed waste paper. Brightness, ISO,% of unbleached deinked pulp of old mixed waste papers was 50.38% and bleached deinked pulp was 63.05 i.e. 13 points gain in brightness was achieved for old mixed waste paper on bleaching. Brightness of unbleached and bleached deinked pulps of old magazines and periodicals was 65.71 and 77.55% ISO, respectively i.e. 12 points gain was achieved on bleaching.

Results recorded in Table 3 revealed that writing and printing paper produced on Fourdrinier machine possessed adequate strength properties; burst index, 2.51 ± 0.38; tensile index, 29.85 ±2.31 and 20.81 ± 2.60 in machine and cross directions and tear index, 1.65 ± 0.31 and 1.95 ± 0.50 in machine and cross directions, respectively. The strength properties and brightness were higher for deinked and bleached pulp produced from magazines and periodicals as compared deinked old mixed papers. However, in general,. on aging the paper produced from old magazines and periodicals exhibited higher drop in strength properties as compared to the paper produced from old mixed waste papers. Runnability of papers on paper machine was satisfactory, in both the cases.

Conclusion

It was concluded that by adopting the simple short sequence deinking technique following advantages could be achieved.

- Reduction in chemical and furnish cost to produce the paper with adequate strength and optical properties.
- No addition of capital intensive deinking equipment/system is required.
- Higher pulp yield at lower mechanical and electrical energy inputs coupled with lower pollution due to better recovery of fibres at lower chemical charge.

Acknowledgement

We offer our sincere thanks to Dr. S.V. Singh, Scientist-SF, Head, Cellulose and Paper Division, Forest Research Institute, Dehra Dun for fruitful discussion.

SUMMARY

Short Sequence Deinking (SSD) of office waste, computer waste, magazines and newsprints was carried out using different doses of NaOH, Na_2CO_3 and detergent followed by their bleaching. 2% hypochlorite was used for office and computer waste deinked pulps while deinked pulps from magazines and newsprints were bleached with 1.2% H_2O_2. Strength and optical properties of both the pulps were adequate for newsprint production however, these were comparatively better for pulp produced using Na_2CO_3 as deinking chemical at laboratory scale. Pilot plant trials using sodium hydroxide (1.5%) and sodium silicate (3.0%) as deinking chemicals was carried out at 70°C temperature and 8% consistency in hydrapulper for one hour. Magnesium sulphate (0.50%), chelating agent (0.25%) and hydrogen peroxide (1.0%) were added to pulps and bleached for one hour for further brightening of pulps. Deinked and bleached pulp yield was 85.87% for old mixed waste papers and 79.79% for old magazines and periodicals. Paper possessing adequate strength properties; burst index, 2.51 ± 0.38; tensile 29.85 ± 2.31 and 20.81 ± 2.60 in machine and cross direction and tear index, 1.65 ± 0.31 and 1.95 ± 0.50 in machine and cross directions, respectively, was made on pilot plant. Brightness of deinked and bleached pulp was 70.30 ± 7.25. Strength properties and brightness were higher for pulp produced from magazines and periodicals as compared old mixed papers. Similar was the trend for strength properties and brightness of papers after aging. Runnability of papers on paper machine was satisfactory, in both the cases. Deinking conditions and paper making parameters on pilot plant are discussed in the paper.

रद्दी कागजों की स्याही निकालने की लघु क्रिया और दिग्दर्शक संयन्त्र परीक्षणों में भिन्न रासायनों का इस पर प्रभाव

अनिता श्रीवास्तव, एस०एन० ढौंडियाल व के०एस० भण्डारी

सारांश

दफ्तरी रद्दी कागज, संगणित्र रद्दी, पत्रिकाओं और अखबारों की स्याही निकालने की लघु प्रक्रिया को एनए ओएच, एनए$_2$सीआ$_3$ और प्रक्षालक की भिन्न-भिन्न मात्राएँ उपयोग में लाकर देखा गया जिसके बाद उनका विरंजन किया गया। 2% हाइपोक्लोराइट स्याही निकाली दफ्तरी और संगणित रद्दी की लुगदी बनाने के लिए उपयोग किया गया जबकि पत्रिकाओं और अखबारी कागज़ों की स्याही निकाली लुगदियाँ 1.2% एच$_2$ओ$_2$ से विरंजित हो गई । दोनों लुगदियों की शक्ति और प्रकाश विशिष्ताएँ अखबारी कागज़ बनाने के लिए पर्याप्त रही किन्तु प्रयोगशाला स्तर पर स्याही निकालने के लिए एनए$_2$सीओ$_3$ उपयोग में लाने पर ये और भी अच्छी बन गई । स्याही निकालने के लिए सोडियम हाइड्रोक्साइड (1.5%) और सोडियम सिलिकेट (3.0%) उपयोग में लाकर दिग्दर्शक संयन्त्र परीक्षण 70° से० तापमान 8% गाढ़ता पर हाइड्रापल्पर में एक घंटे तक किए गए । लुगदियों में मैग्नीशियम सल्फेट (0.50%) नखरीयण अभिकरण (0.25%) और हाइड्रोजन पेरोक्साइड (1%) मिलाए गए और लुगदी में चमक लाने के लिए उनका एक घंटे तक और विरंजन किया गया । स्याही निकाली विरंजित लुगदी की प्राप्ति पुराने मिले-जुले रद्दी कागज़ों में 85.87% तथा पुरानी पत्र-पत्रिकाओं में 79.79% रही । पर्याप्त शक्ति विशिष्ताओं वाले कागज, विस्फोट निर्देशांक 2.51±0.38, आतनन शक्ति 29.85±2.31 और 20.81± मशीन पर तथा आरपार दिशा में और फटन निर्देशांक 1.65±0.31 और 1.95±0.50 क्रमशः मशीन में और आरपार दिशा में दिग्दर्शक संयन्त्र पर बना लिए गए। स्याही निकाली विरंजित लुगदी की चमक 70.30±7.25 रही । पत्र-पत्रिकाओं से बनाई लुगदी की चमक मिले जुले कागज़ों से बनाई लुगदी की चमक से अधिक रही । पुराना पड़ने पर भी कागज़ों की शक्ति विशिष्टताओं और चमक की यही प्रवृति बनी रही । कागज़ मशीन पर कागज़ों के चलने की योग्यता दोनों दशाओं में संतोषप्रद रही । अभिपत्र में स्याही निकालने की दशाओं और दिग्दर्शक संयन्त्र पर कागज़ बनाने के परिमापों का विवेचन भी किया गया है ।

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SEED CULTURE OF *PHAIUS TANKERVILLIAE* BL.

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Introduction

Phaius tankervilliae Bl., commonly known as Nun's orchid, occupies a place of prominence amongst the terrestrial orchids of N.E. India on account of its immense floricultural appeal. Like many other orchids in the region, this orchid species is also considered to be endangered in the face of large scale denudation of forest areas. Development of a suitable method such as *in-vitro* culture of its seeds, offers hope in preserving it from possible extinction. The present study was made to find out a suitable medium for seed culture of this orchid and to find out the proper stage of seed development at which the seeds could be cultured successfully.

Material and Methods

Mature plants of *Phaius tankervilliae*, earlier collected from the Tengakhat Reserve Forest of Dibrugarh District of Assam and maintained in the Departmental Orchidarium, Assam Agricultural University, Jorhat, were utilised for the present study. Seeds of different age groups (50, 80, 110, 140, 170 and 230 days old) were cultured in 3 different media, Knudson C (Knudson, 1946), N_3f (Burgeff, 1936) and Nitsch and Nitsch (1969). With a view to improve germination and promote further growth of the protocorms, 140 days old seeds were also cultured in the Nitsch and Nitsch medium supplemented separately with 20 ml/l of coconut water, pineapple juice and banana extract. Coconut water was obtained from fully matured nut (var. Tall) boiled, and filtered. Pineapple juice was extracted from fully matured fruit (var. Kew). 100 g of pulp from ripe banana fruit (var. Dwarf carvendish; genomic group - AAA) was thoroughly macerated in a mortar after adding 200 ml of distilled water to it. The mixture was then filtered to obtained the banana extract.

All the inoculated culture vessels were incubated at a temperature of 26° ± 1°C under a 12 hr light (100 lux) and dark cycle. In the present study, germination of seeds has been defined as formation of protocorms.

Results and Discussion

Very immature seeds (50-80 days old) failed to show any response when cultured in the 3 basal media. Thereafter, germination increased progressively with the increase in the age of the seeds and maximum germination of 70% was observed when 170 days old seeds were cultured in Nitsch and Nitsch medium. Older seeds (140-170 days old) also took shorter period (4-6 weeks) for germination in the same medium while the younger ones (80-110 days old) took much longer period (8-10 weeks) (Table 1).

Table 1

Response of Phaius tankervilliae seeds cultured in defined and fruit juice supplemented media

Age of seeds (days)	Medium	Time taken (in weeks) for the development of						
		Green protocorms	Protocorms with pointed vegetative apices	Absorbing hairs	Plantlets showing leaflets	Plantlets showing two spreading leaflets	Roots	Germination (%)
50	A	-	-	-	-	-	-	0
	B	-	-	-	-	-	-	0
	C	-	-	-	-	-	-	0
80	A	-	-	-	-	-	-	0
	B	-	-	-	-	-	-	0
	C	10	12	15	20	-	-	1
110	A	10	12	-	-	-	-	5
	B	10	12	-	-	-	-	10
	C	8	10	12	16	20	22	30
150	A	9	12	-	20	24	-	5
	B	7	12	-	20	24	-	10
	C	6	8	8	12	16	18	50
	C + CW	4	6	8	8	12	15	90
	C + PJ	4	6	8	12	15	17	90
	C + BE	4	6	8	8	10	13	50
170	C	4	5	7	10	12	15	70
230	C	7	10	10	14	17	-	40

A - Knudson C; B - N_3f; C - Nitsch & Nitsch; CW - Coconut water (20 ml/l); PJ - Pineapple juice (20 ml/l); BE - Banana extract (20 ml/l).

The responses of the cultured seeds clearly showed that the seeds of different age groups were not at their same level of maturation. A minimum maturation time should be allowed to the seeds to develop so that they attain a stage for absorbing the nutrients from the medium. Mitra (1971) observed that seeds of unbursted capsules of *Arundina bambusifolia* took a considerably longer period (41 days) than the seeds of bursted capsules (18 days) for germination which conform with this study. However, in the present study, culture of mature seeds (230 days old) harvested just prior to bursting of capsules, showed lower percentage of germination (40%). Moreover, these seeds took longer duration to germinate and further growth of the protocorms was also slower (Table 1). Among the 3 basal media used, Nitsch and Nitsch medium was found to be most suitable. Nishimura (1982) also recommended the use of Nitsch and Nitsch medium for embryo culture of *Calanthe insularis*, a terrestrial orchid.

In coconut water and pineapple juice (20 ml/l) supplemented Nitsch and Nitsch medium germination of seeds could be enhanced to 90% (Table 1). No improvement in germination was observed when banana extract was added. However, growth of the protocorms was found to be promoted in the banana extract (20 ml/l) supplemented medium. Beneficial effect of fruit juices on germination of orchid seeds was also reported by several workers but at very high concentrations (Fast, 1978; Hegarty, 1955; Graeflinger 1950; Mayer, 1945).

SUMMARY

Nitsch and Nitsch (1969) medium was found to be the most suitable medium for the germination of seeds of *Phaius tankervilliae* Bl., an endangered orchid species of N.E. India. Good germination (70%) was observed when 170 days old seeds of this orchid were cultured in this medium. Germination could be further enhanced by growing the seeds in the same medium supplemented with coconut water or pineapple juice (20 ml/l). Addition of banana extract (20 ml/l) in the medium resulted better growth and development of the seedling after germination.

फाइउस टैंकरविल्लएइ ब्ल० के बीजों का संवर्धन

जे० भुइयां व पी०सी० डेका

सारांश

उत्तर पूर्व भारत की विलुप्ति खतरे में पड़ी पीनशिफ जाति *फाइउस टैंकरविल्लएइ* ब्ल० के बीजों का अकुंरण कराने के लिए नित्श व नित्श (1969) माध्यम सबसे उपयुक्त माध्यम पाया गया । इस पीनशिफ के 170 दिनों तक इस माध्यम में संवर्धित बीजों का अच्छा अंकुरण (70%) होता पाया । इस माध्यम में यदि नारियल पानी अथवा अन्नास का रस या (20 मिलि/लि) और मिलाया जाए तो बीजों का उगना और सुधारा जा सकता है । इस माध्यम में केले का निस्सार (20 मिलि/लि) मिलाने से अंकुरण के पश्चात् पौधे की बढ़वार और विकास और भी अच्छे हो जाएंगे ।

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NEW FOREST, DEHRA DUN, INDIA : A UNIQUE MAN-MADE HABITAT FOR BUTTERFLIES IN THE LOWER WESTERN HIMALAYAS

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Introduction

Butterflies of the Oriental region have been extensively studied in the past (Niceville and Marshall, 1882; Niceville, 1986-90; Moore, 1890-1907; Bingham, 1905-1907; Swinhoe, 1905-1913; Evans, 1932; Talbot, 1939-1947; Wynter-Blyth, 1957; D'Abera, 1982-85; Mani, 1986; Smith, 1989 and Haribal, 1992). As many as 417 species, both Himalayan (Palaeartic) and Oriental forms, are known from the Western Himalaya out of about 1,439 species and 2,550 sub-species which are found in the Indian Sub-Continent (Wynter-Blyth, 1957).

Study Area

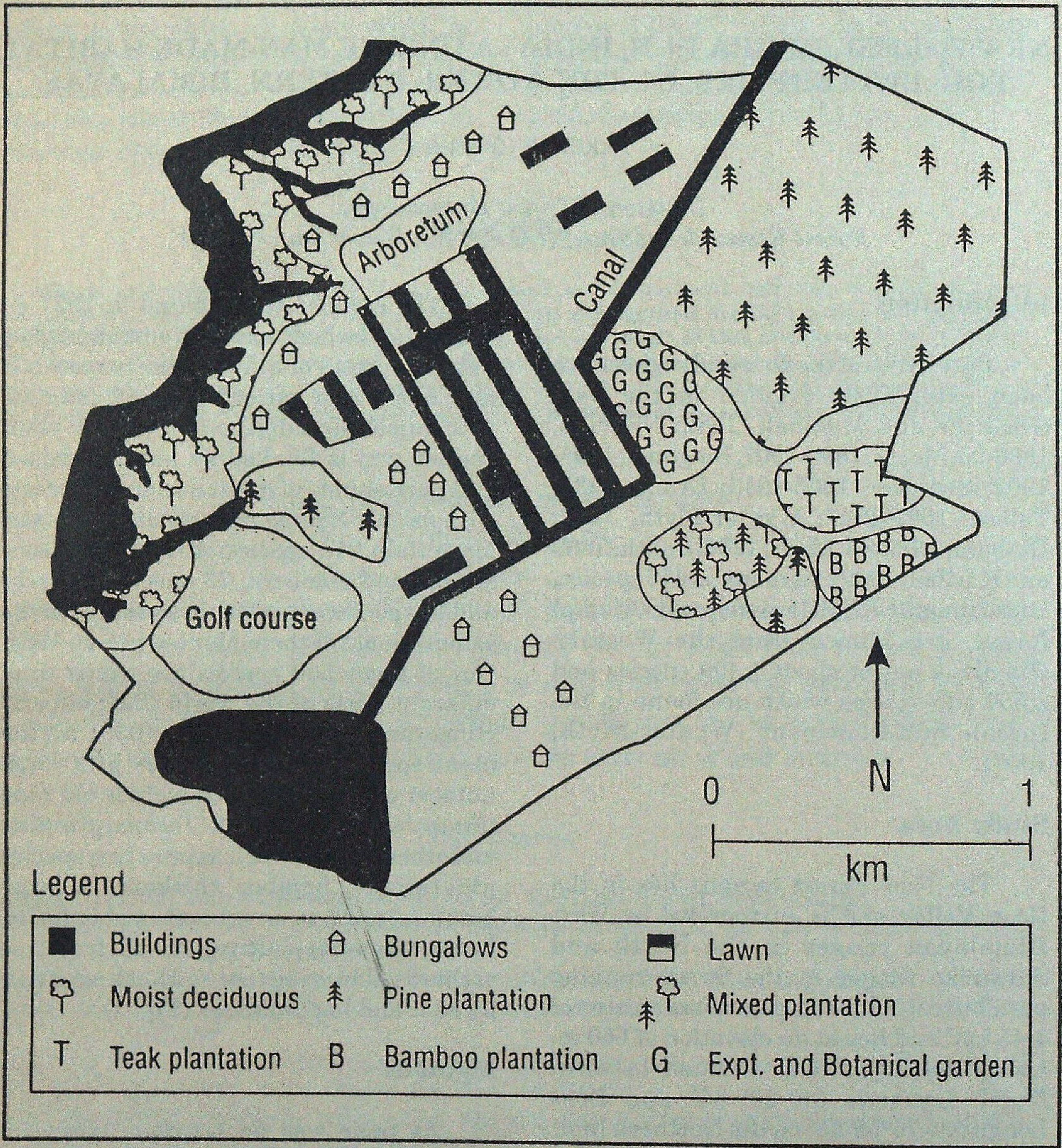
The New Forest campus lies in the Doon Valley and is surrounded by West Himalayan ranges in the North and Shiwaliks ranges in the South running parallel to it. This campus covers an area of 4.45 km^2 and lies at an elevation of 660 m, above sea level. It is situated between North Latitude 30° 20' 35" and East Longitude 70° 59' 55" on the Northern limit of the Oriental region. The annual rainfall is over 200 cm, bulk of which falls as South-West monsoon from June-September. The temperature fluctuates between 1°C to 42°C from winter to summer. The annual mean temperature being 20°C.

The campus was created in 1927 on village land which was then surrounded by natural forests of Sal (*Shorea robusta*). It now has a rich variety of forest habitats with numerous indigenous and exotic plant species and is flanked by natural, mixed and pure stands of moist deciduous forests with mainly *Shorea robusta* on the slopes. More than 972 species of trees, bamboos, shrubs and climbers, 73 species of herbs and 28 species of grasses are present in the campus most of them planted before 1954. Out of these 500 species are exotic from different parts of the world (Raizada and Hingorani, 1954; Bahuguna, 1990). All the plant species are spread over in a large number of habitats which include old Pine (*Pinus roxburghii*), Teak (*Tectona grandis*) and other mixed as well as pure tree species plantations, bamboo thickets, a large botanical garden, an arboretum, big fields, lawns, nurseries, cultivated land, fruit tree orchards, flowering tree and bush avenues, a canal and big buildings (Fig. 1).

Methods

As their was no previous record of butterflies from the study area, the butterflies were observed and collected from different habitats spread all over the New Forest campus. Collection was done in all the seasons for six years (1988 to 1992 and 1997-1998). Only a few specimens (1-4) of

Fig. 1


Arboretum
Canal
Golf course
N
0
1
km
Legend
Buildings
Bungalows
Lawn
Moist deciduous
Pine plantation
Mixed plantation
T Teak plantation
B Bamboo plantation
G Expt. and Botanical garden

Map of New Forest, Dehra Dun

each species were caught. These were then set, dried, labelled, preserved and identified with help of books (Evans, 1932; Wynter-Blyth, 1957; D'Abera, 1982-85; Smith, 1989; Haribal, 1992). The larval food plant species of all the butterflies present in the study area were known from the literature (Wynter-Blyth, 1957; Haribal, 1992). Their presence in New Forest was confirmed visually and also from literature (Raizada and Hingorani, 1954; Bahuguna, 1990).

The view that proportions of butterfly species in families and sub-families are reasonably invariant or relatively constant in Neo-tropical forests in Latin America (Beccaloni and Gaston, 1995), was also examined for the Oriental region taking New Forest in comparison with the Western Himalayas, Central Himalayas and the entire Indian sub-continent separately, to prove this hypothesis. This was also done to find out if New Forest, an artificial habitat, could support and represent the original butterfly species richness of the region (Western Himalayas).

Results and Discussion

As many as 148 species of butterflies belonging to 102 genera and 10 families and sub-families were collected (Appendix 1). Three species occurred as more than 1 race (i.e. sub-species). Most of the species belonged to Oriental region (94 per cent) while the rest were from the Himalayan region. Three species observed were recorded as "rare" as listed in the Schedule II of the Indian Wildlife Protection Act (1972, amended 1989). A unique observation was that larval food plant species for all the 148 species of butterflies caught were present in the New Forest campus.

The proportions of species in families of butterflies found in New Forest, Dehra Dun were found to be in constancy with the proportions of species of families of the Western Himalayas (Table 1), although New Forest is a man-made habitat having natural vegetation only in some of its parts i.e. on its North-Western fringes (Fig. 1). This constancy for proportion of species in families found in New Forest was more close to the Western Himalayas as compared to the Central Himalayas (Nepal) or the entire Indian Sub-Continent. These findings reveal that the hypothesis suggested by Baccaloni and Gaston (1995) that "the proportion of butterfly species in families is constant for a particular forests in Neo-tropics" is also relevant for butterflies of the Oriental region.

In can be concluded from the above study that New Forest campus provides a

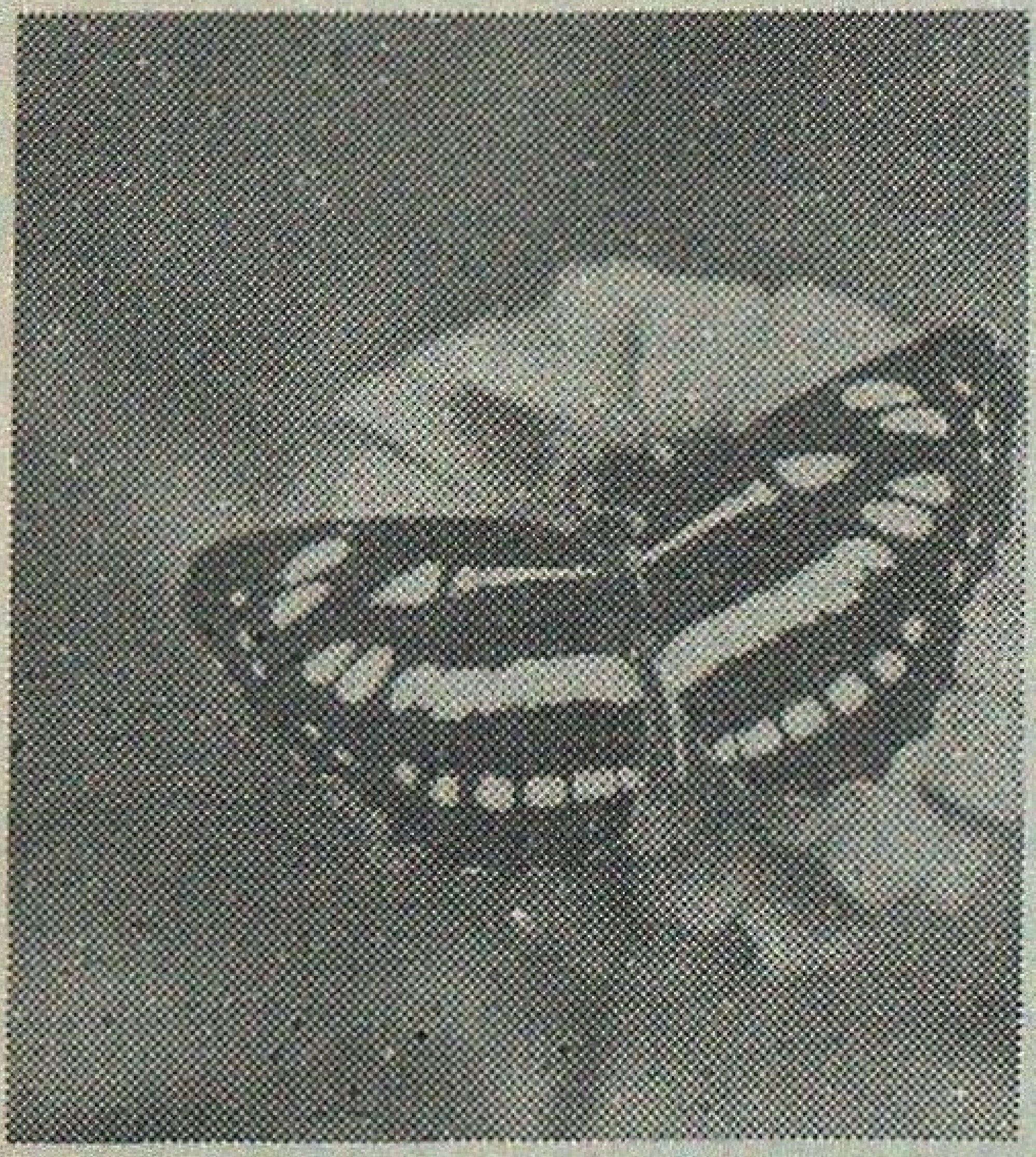
Table 1

Comparison of proportion of species in the families of butterflies recorded from New Forest, Dehra Dun with different Indian regions

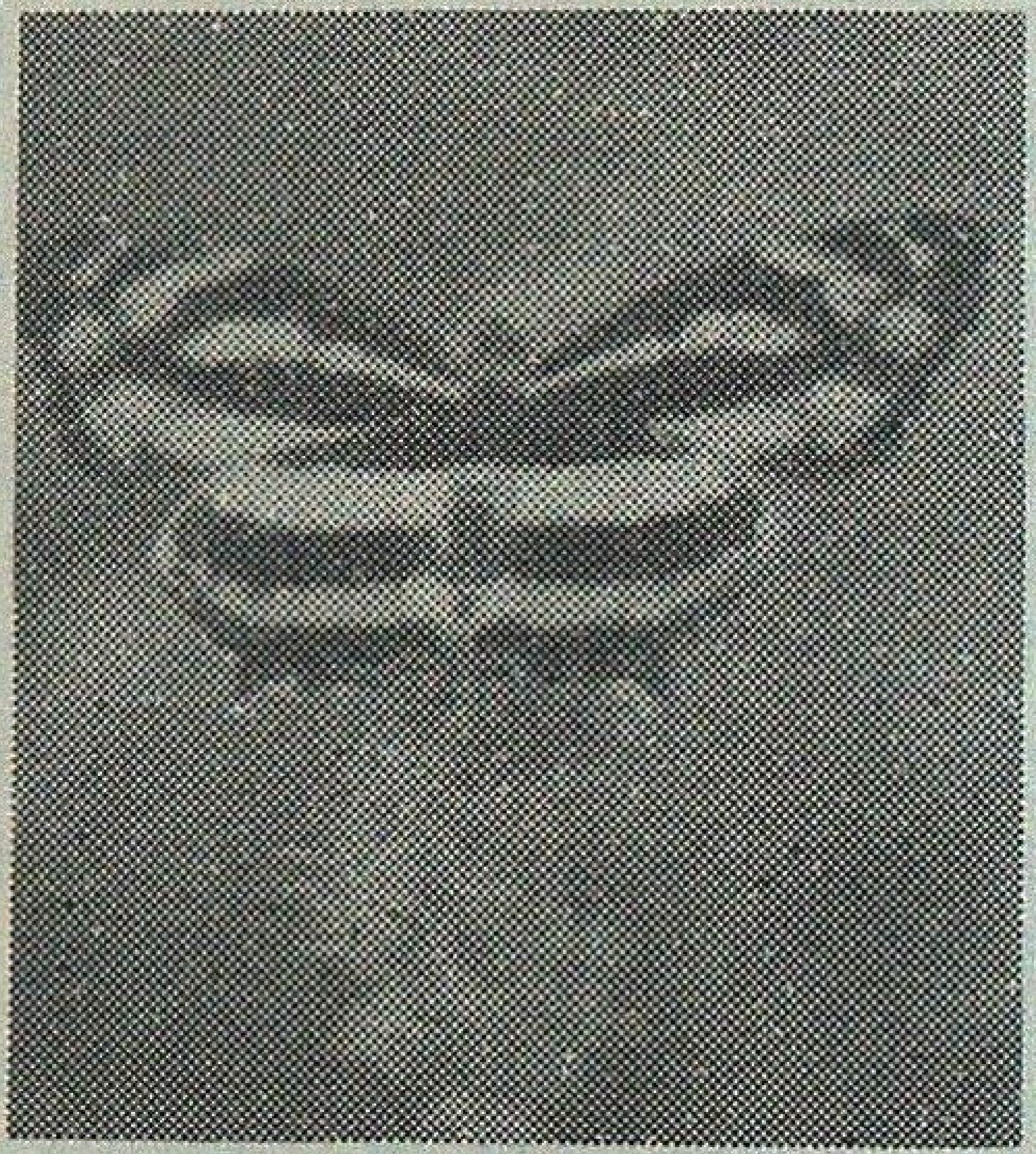
Regions	Total Butterfly species	Percentage of Total				
		Hesperidae	Papilionidae	Pieridae	Lycaenidae	Nymphalidae
New Forest, Dehra Dun	148	14.8	07.4	12.8	27.5	37.6
Western Himalaya*	417	15.1	07.4	10.1	29.3	38.0
Central Himalaya**	623	20.1	06.9	07.9	29.7	35.3
Indian Sub-Continent*	1439	21.3	06.5	06.9	31.8	33.3

(Sources : * Wynter-Blyth, 1957; ** Haribal, 1992)

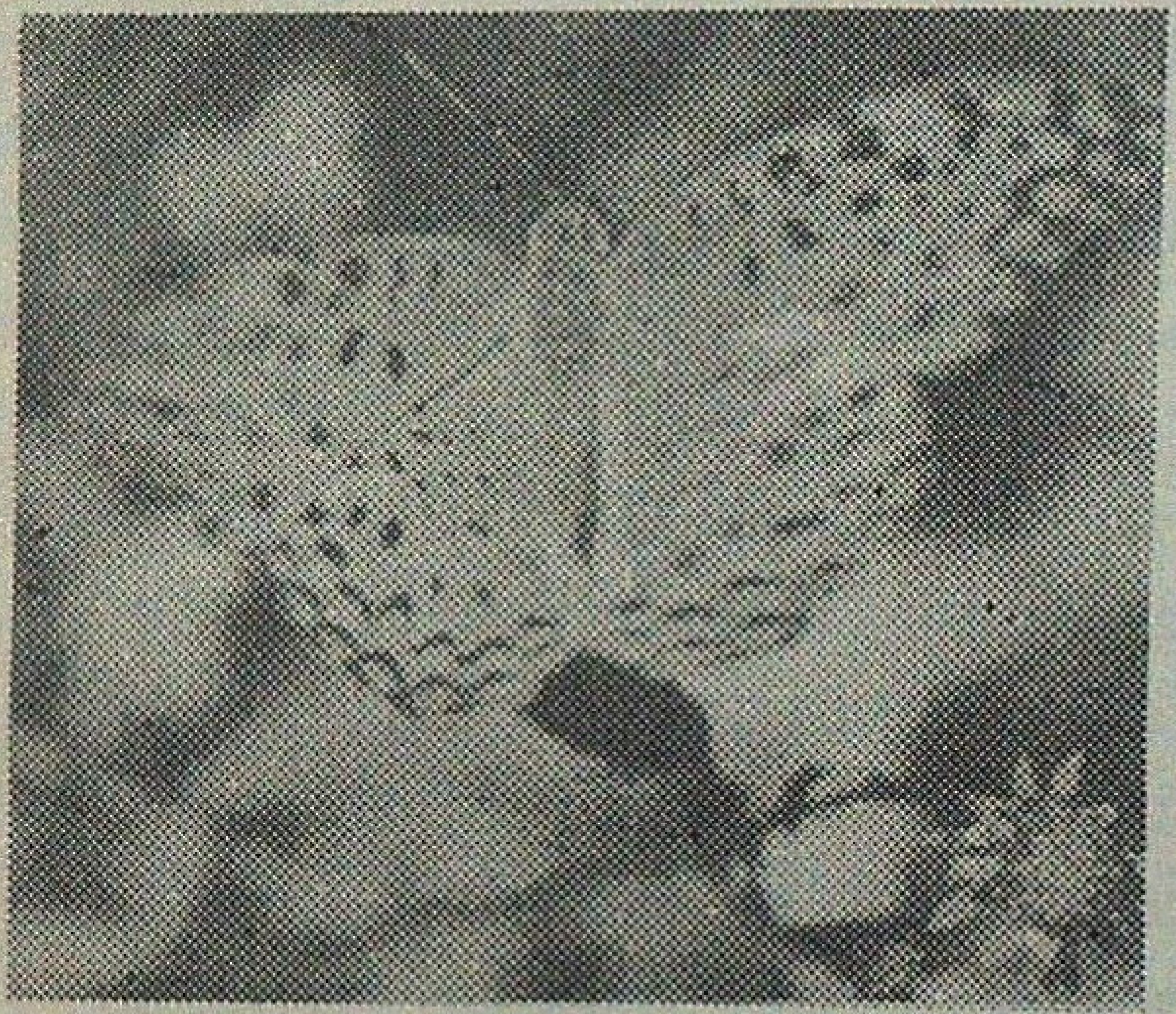
Fig. 2



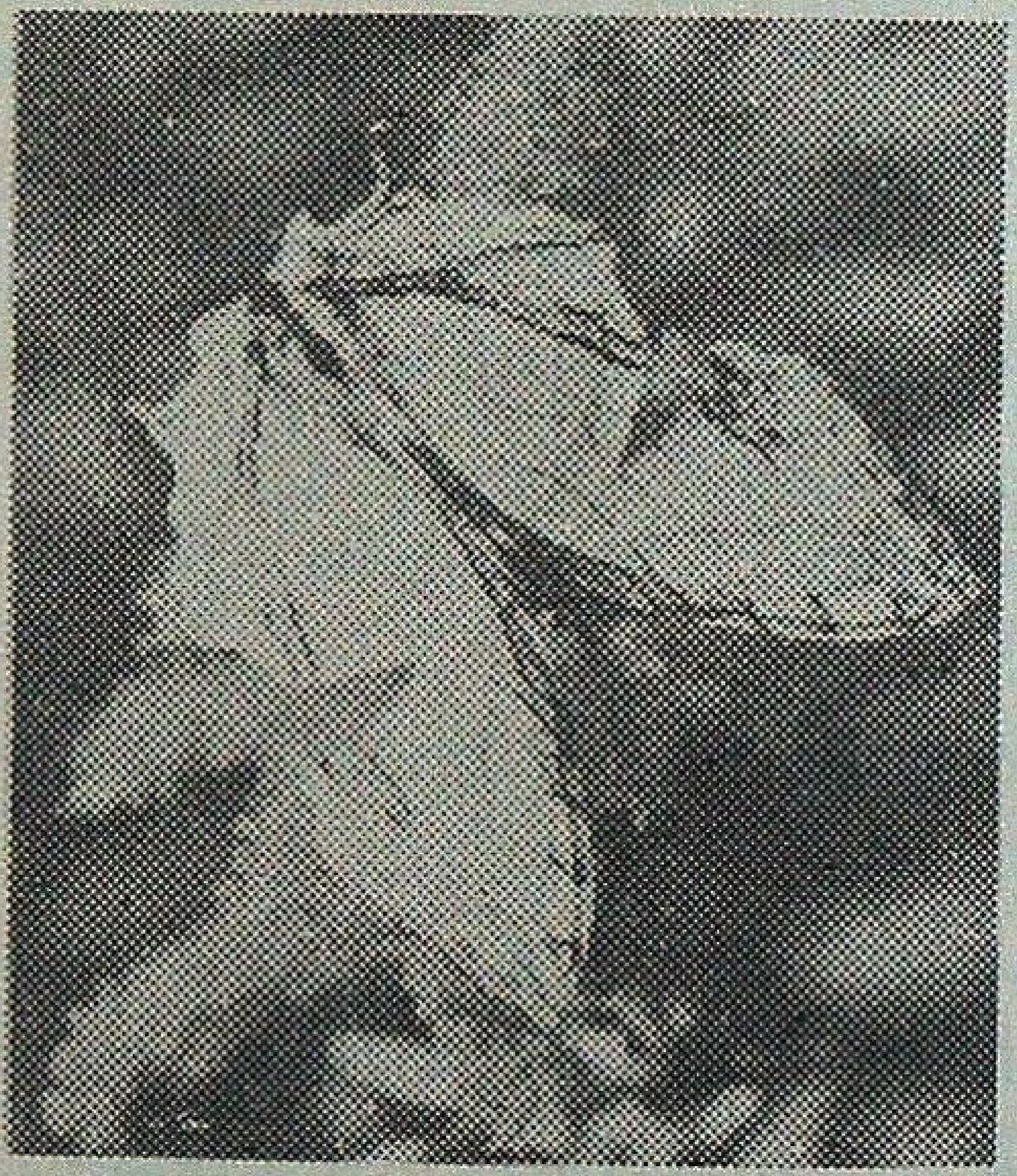
Neptis hylas (Common Sailor)



Symbrenthia lilaea (Common Jester)

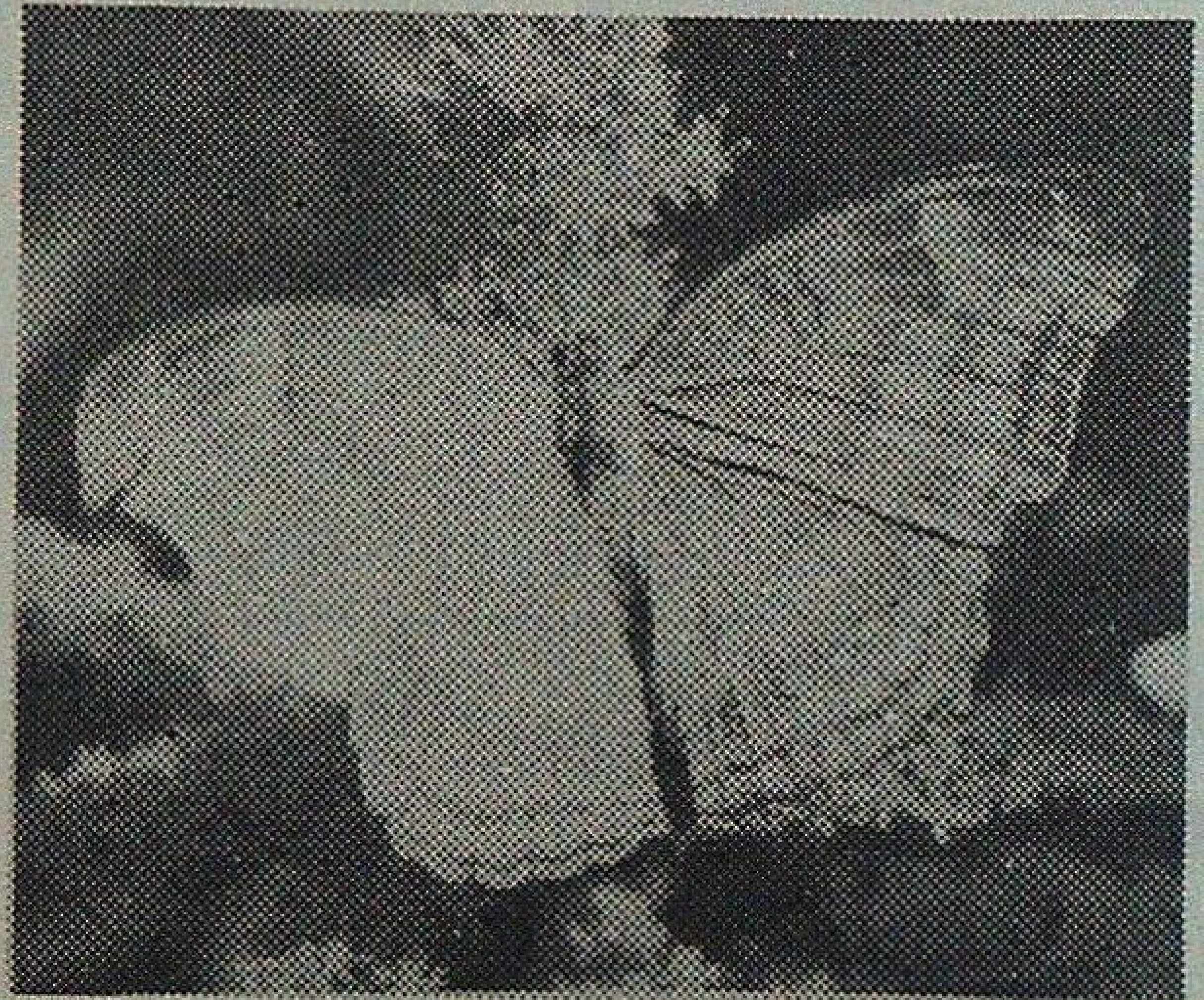


Phalantha phalantha (Common Leopard)



Cyrestis thyodamas (Common Map)

Euthalea aconthea (Common Baron)



Precis iphita (Choclate Pansy)

unique and rich mosaic of habitats, having numerous food plant species of butterflies (both larval food and adult nectar sources) and supports one-third (35.7 per cent) of the total number of butterfly species found in the Western Himalayas which belong mostly to the Oriental region. Thus, New Forest is an important and unique habitat depicting a point diversity of butterflies of the Western Himalayas and should be protected and preserved for conserving this diversity.

Appendix 1

Systematic Check List of Butterflies of New Forest, Dehra Dun

Sl. No.	Family/Sub-family Genus - Species - Sub-species	Common Name
1	2	3
I.	Papilionidae :	
1.	*Princeps protenor protenor*, Fruhs.	Spangle
2a.	*Princeps polytes stichus*, Linn.	Common Mormon
2b.	*Princeps polytes romulus*, Cramer.	Common Mormon
2c.	*Princeps polytes polytes*, Linn.	Common Mormon
3.	*Princeps demoleus demoleus*, Linn.	Lime Butterfly
4.	*Papilio machoan emihippocrates*, Linn.***	Common Yellow Swallow Tail
5.	*Princeps paris paris*, Linn.	Paris Peacock
6.	*Pachliopta aristolochiae aristolochiae*, Fab.	Common Rose
7.	*Graphium agammemnon agammemnon*, Linn.	Tailed Jay
8.	*Graphium sarpedon sarpedon*, Linn.	Common Blue Bottle
9.	*Graphium cloanthus*, Westwood	Glassy Blue Bottle
10.	*Chilasa clytia clytia*, Linn.	Common Mime
11.	*Chilasa agestor agestor*, Gray.***	Twany Mime
II.	Pieridae :	
12.	*Eurema andersoni andersoni* Moore	One Spot Grass Yellow
13.	*Eurema blanda silhetana*, Wallace	Three Spot Grass Yellow
14.	*Eurema hecabe counterbernalis*, Moore	Common Grass Yellow
15.	*Colias fieldii*, Menetries***	Dark Clouded Yellow
16a.	*Colias erate glicia*, Linn.	Pale Clouded Yellow
16b.	*Colias erate pallida*, Esper	Pale Clouded Yellow
17.	*Delias eucharis*, Drury	Common Jezebell
18.	*Delias sanaca sanaca*, Moore***	Hill Jazebell
19a.	*Parenonia valeria philomela*, Cramer	Common wanderer
19b.	*Parenonia valeria hippa*, Fab.	Common wanderer
20.	*Pontia dalplidice moorei*, Rober***	Bath White

Contd...

1	2	3
21.	*Anapheis aurota aurota*, Fab.	Pioneer
22.	*Cepora nerissa nerissa*, Fab.	Common Gull
23.	*Pieris brassicae*, Linn.***	Large Cabbage White
24.	*Pieris canidia indica*, Evans	Indian Cabbage White
25.	*Goneteryx nhamni nepalensis*, Doubleday***	Common Brimstone
26.	*Leptosia nina nina*, Fab.	Psyche
27.	*Ixias marianne*, Cramer	White Orange Tip
28.	*Catopsila florella*, Fab.	African Emigrant
29.	*Catopsila pomona*, Fab.	Lemon Emigrant
30.	*Catopsila crocale*, Cramer	Common Emigrant
III.	Lycaenidae :	
(i)	Lycaeninae :	
31.	*Poritia hewitsoni hewitsoni*, Moore	Common Gem
32.	*Curetis dentata dentata*, Moore	Angled Sub Beam
33.	*Iraota timoleon*, Stoll	Silver Streak Blue
34.	*Arhopala amantes apella*, Swinhoe	Large Oak Blue
35.	*Arhopala atrax*, Hewitsoni	Indian Oak Blue
36.	*Sundera quercetorum quercetorum*, Moore	Common Acacia Blue
37.	*Loxura atymnus continentalis*, Fruhs.	Yam Fly
38.	*Horage onyx onyx*, Moore*	Common Onyx
39.	*Horaga albimacula viola*, Moore*	Brown Onyx
40.	*Spindasis lunulifera lunulifera*, Moore	Silver Line
41.	*Spindaisis vulcanus vulcanus*, Fabricus.	Common silverline
42.	*Sinthusa chandrana grotei*, Moore	Broad Spark
43.	*Rapala manea schistacea*, Moore	Slate Flash
44.	*Rapala varuna orseis*, Moore*	Indigo Flash
45.	*Rapala dieneces dieneces*, Hewitsoni	Scarlet Flash
46.	*Rapala jarbus sorya*, Kollar	Common Red Flash
47.	*Heliphorus sena*, Kollar	Sorrel Sapphire
48.	*Edales pandava pandava*, Horsfield	Plains Cupid
49.	*Chilades lajus lajus*, Stoll	Lime Blue
50.	*Everis lacturnus syntala*, Cantlie	Indian Cupid
51.	*Castaluis rosimon rosimon*, Fab.	Common Pierrot
52.	*Tarucus nara*, Kollar	Striped Pierrot
53.	*Syntarucus plinius*, Fab.	Zebra Blue
54.	*Freyeria putli*, Kollar	Least Grass Jewel
55.	*Zizina otis otis*, Fab.	Lesser Grass Blue
56.	*Zizeeria maha ossa*, Swinhoe	Pale Grass Blue
57.	*Zizeeria knyasna*, Moore	Dark Grass Blue
58.	*Prosotas nora ardates*, Moore	Common Line Blue

Contd...

1	2	3
59.	*Prosotas dubiosa indica*, Evans	Tailess Line Blue
60.	*Zesius chrysomallus*, Hubner	Red Spot
61.	*Catochrysops strabo*, Fab.	Forget- Me - Not Blue
62.	*Tajuria cippus cippus*, Fab.	Peacock Royal
63.	*Acetolepis puspa gisca*, Fruhs.	Common Hedge Blue
64.	*Lycaenopsis marginata marginata*, De Niceville	Margined Hedge Blue
65.	*Lycaenopsis transpectus*, Moore	White Banded Hedge Blue
66.	*Celastrina dilecta*, Moore	Pale Hedge Blue
67.	*Euchrysops cnejus*, Fab.	Gram Blue
68.	*Lampides boeticus*, Linn.	Pea Blue
69.	*Celastrina argiolus*, Linn.	Hill Hedge Blue
70.	*Neo-pithecops zalmora*, Butler	Common Quaker
71.	*Jamides celeno aelianus*, Fabricus.	Common Carulean
(ii)	Riodinidae :	
72.	*Abisara echerius suffusa,* Moore	Plum Judy
IV.	Nymphalidae :	
(i)	Libythenae :	
73.	*Libythea myrrha sanguinalis*, Fruhs.	Club Beak
(ii)	Acraeinae :	
74.	*Acraea violae*, Horsfield.	Twany Coster
75.	*Pareba vesta*, Fabricus.	Yellow Coster
(iii)	Nymphalinae :	
76.	*Ariadne ariadne indica*, Moore	Angled Coster
77.	*Ariadne merione tapestrina*, Moore	Common Coster
78.	*Cupha erymanthis lotis*, Sulzer	Rustic
79.	*Phalantha phalantha*, Drury	Common Leapord
80.	*Issoria sinha sinha*, Kollar	Vagrant
81.	*Argyreus hyperbius hyperbius*, Linn.	Indian Fritillary
82.	*Vanessa indica indica*, Hebrst	Red Admiral
83.	*Cynthia cardui*, Linn.	Painted lady
84.	*Kaniska canace canace*, Linn.	Blue Admiral
85.	*Aglais cashmirensis aesis*, Kollar	Indian Tortoise Shell
86.	*Precis lemonias lemonias,* Linn.	Lemon Pansy
87.	*Junonia orithya ocyale*, Hubner	Blue Pansy
88.	*Junonia hierta magna*, Fab.	Yellow Pansy
89.	*Precis atlites*, Linn.	Grey Pansy
90.	*Precis iphita iphita*, Cramer.	Choclate Pansy

Contd...

1	2	3
91.	*Precis almana almana*, Linn.	Peacock Pansy
92.	*Symbrenthia lilaea khasiana*, Moore	Common Jester
93.	*Pantoporia hordonia hordonia*, Stoll	Common Lascar
94.	*Cyrestis thyodamas thyodamas*, Boisduval	Common Map
95.	*Neptis yerburi pandoces*, Eliot	Yerbury's Sailer
96.	*Neptis sappho astola*, Moore	Palla's Sailer
97.	*Neptis hylas varmina*, Moore	Common Sailer
98.	*Neptis mahendra*, Moore	Himalayan Sailor
99.	*Parathyma perius perius*, Linn.	Common Sergeant
100.	*Parathyma selenophora selenophora*, Kollar	Staff Sergeant
101.	*Parathyma opalina opalina*, Kollar	Hill Sergeant
102.	*Modriza procris procris*	Commander
103.	*Euthalia lubentina indica*, Fab.	Gaudy Baron
104.	*Euthalia aconthea anagama*, Fruhs.	Common Baron
105.	*Polynura athamas athamas*, Drury	Common Nawab
106.	*Tanaccia lepidea lepidea*, Butler	Grey Count
107.	*Kallima inachus huegeli*, Kollar	Orange Oak Leaf
108.	*Hypolimnas bolina jacintha*, Drury	Great Egg Fly
(iv)	Satyrinae :	
109.	*Elymnias hypermenestra undularis*, Drury	Common Palm Fly
110.	*Melanitis leda leda*, Drury.	Common Evening Brown
111.	*Melanitis phedinia bela*, Linn.	Dark Evening Brown
112.	*Lethe europa niladana*, Fruhs.	Bamboo Tree Brown
113.	*Lethe confusa confusa*, Aurivillius	Banded Tree Brown
114.	*Mycalesis visala visala*, Moore	Long Band Bush Brown
115.	*Mycalesis perseus blasius*, Fab.	Common Bush Brown
116.	*Ypthima huebenri huebenri*, Kirby	Common Four Ring
117.	*Ypthima indecora*, Moore	Western Five Ring
118.	*Ypthima asterope mahratta*, Moore	Common Three Ring
119.	*Ypthima indica*, Hewitsoni	Lesser Three Ring
120.	*Ypthima singala*, Felder	Small Jewel Four Ring
(v)	Danaidae :	
121.	*Tirumala limniace leopardus*, Butler	Blue Glassy Tiger
122.	*Parantica melaneus plantaniston*, Fruhs.	Choclate Tiger
123.	*Euploea core core*, Cramer	Common Indian Crow
124.	*Danaus genutia genutia*, Cramer	Common Tiger
125.	*Danus chrysippus chrysippus*, Linn.	Plain Tiger
126.	*Euploea mulciber mulciber*, Cramer	Striped Blue Crow

Contd...

1	2	3
V.	Hesperiidae :	
127.	*Tagiades litigiosa litigiosa*, Muschler	Water Snow Flat
128.	*Caoladenia dan fatih*, Kollar	Fulvous Pied Flat
129.	*Calodenia indrani indrani*, Moore	Tri Colour Pied Flat
130.	*Sarangesa dasahara dasahara*, Moore	Common Small Flat
131.	*Oriens gola pseudolus*, Mabille	Common Dartlet
132.	*Telicota ancilla bambusae*, Moore	Dark Palm Dart
133.	*Pothanthus pseudomaesa clio*, Evans	Common Indian Dart
134.	*Matapa aria*, Moore	Common Red Eye
135.	*Erionata thrax thrax*, Linn.	Palm Red Eye
136.	*Udaspes folus*, Cramer	Grass Demon
137.	*Notocrypta curvifascia curvifascia*, Felder	Restricted Demon
138.	*Hyarotis adrastus praba*, Moore	Tree Flitter
139.	*Suastus gremius gremius*, Fab.	Indian Palm Bob
140.	*Bibasis jaina jaina*, Moore	Orange Awlet
141.	*Pleopidas sinensis*, Mabille	Large Banded Swift
142.	*Pleiopidas mathias mathias*, Fab.	Small Banded Swift
143.	*Pleiopidas conjunctus conjunctus*, Mabille	Conjoint Swift
144.	*Pleiopidas assamensis*, De Niceville	Great Swift
145.	*Baoris pagana*, De Niceville	Figure of Eight Swift
146.	*Baoris farri farri*, Moore	Paint Brush Swift
147.	*Parnara guttatus mangala*, Moore	Straight Swift
148.	*Polytremis eltola eltola*, Hewitson	Yellow Spot Swift

* = Listed as "rare" in the Schedule II of the Indian Wild life Protection Act, (1972, ammended, 1989).
** = Presence doubtful
*** = Himalayan Form

SUMMARY

Butterflies were collected for six years from New Forest campus which is a man-made habitat covering an area of 4.45 km^2 and located at Dehra Dun in Northern India. The aim of the study was to know butterfly species composition of this artifical habitat in relation to the Western Himalayas and also the number of larval food plant species of butterflies supported by this habitat. A total of 148 species belonging to 10 families and sub-families were found in New Forest which was one-third of the total found in the region. Three species found were 'rare' as listed in the Schedule II of the Indian Wildlife Protection Act (1972, ammended 1989). Larval food plants for all the butterfly species were present in New Forest. The proportions all the butterfly species in the families found here were in constancy with the region and were more closely related to the Western Himalaya, as compared to the Central Himalaya or the entire Indian Sub-Continent. All these findings suggest that New Forest provides a refuge for a large number of butterfly species found in the region, depicting a point diversity.

निम्न पश्चिमी हिमालयी प्रदेश में तितलियों का मानवनिर्मित अप्रतिम प्राकृतावास न्यूफोरेस्ट, देहरादून, भारत

अरुण पी० सिंह

सारांश

न्यूफोरेस्ट से, जो 4.45 किमी^{2} क्षेत्र में फैला हुआ मानव निर्मित प्राकृतावास तथा उत्तरी भारत में देहरादून में स्थित है, 6 वर्षो तक तितलियों का संग्रह किया गया । इस अध्ययन का उद्देश्य पश्चिमी हिमालय प्रदेश के संदर्भ में इस कृत्रिम प्राकृतावास में तितली जातियों की संरचना जानना तथा इस प्राकृतावास द्वारा संपोषित तितली जातियों के जातकों का भोजन बनने वाली पादप जातियों की संख्या की जानकारी प्राप्त करना था । 10 वंशों और उप वंशों की कुल मिलाकर 148 जातियाँ न्यूफोरेस्ट में पाई गई जो पूरे प्रदेश में पाई जाने वाली तितलियों का एक तिहाई होती हैं । यहाँ मिली तीन जातियाँ दुर्लभ हैं जिन्हें भारतीय वन्य प्राणि अधिनियम, (1972, संशोधित 1989) की अनूसूचि II में ऐसा बताया हुआ है। सभी तितली जातियों के जातक भोजन पौधे न्यूफोरेस्ट में उपलब्ध हैं । सभी तितली वंशों में मिलने वाली जातियों का समानुपात यहाँ ठीक वैसा ही है जैसा कि प्रदेश में है और मध्य हिमालय क्षेत्र अथवा पूरे उप महाद्वीप के साथ तुलना करने पर उसकी अपेक्षा पश्चिम हिमालयी क्षेत्र के साथ अधिक निकटता से संबन्धित है । ये सारी जानकारियाँ सुझाती हैं कि न्यूफोरेस्ट इस क्षेत्र में पाई जाने वाली तितलियों की बहुत बड़ी संख्या को शरण्य प्रदान करता है और विविधता का बिन्दु बताने वाला है ।

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GROWTH AND WOOD TRAITS OF PLANTATION GROWN *ACACIA MANGIUM, A. AURICULIFORMIS* AND *A. CRASSICARPA* FROM THANE, MAHARASHTRA

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Introduction

Acacia species native to Australia are increasingly raised as plantations in the humid tropical Asian countries. Four major species, in particular *Acacia auriculiformis*, and *A. mangium* and to a lesser extent *A. crassicarpa* have been planted in over 8,00,000 hectares in South-East Asia (Matheson and Hardwood, 1997). These leguminous nitrogen fixing trees are widely used for afforesting degraded areas and grasslands in Malaysia, the Philippines and Indonesia. *A. auriculiformis* was first introduced to India in West Bengal (Bulgannawar and Math, 1991) and since then has been extensively planted for fuel and pulpwood. The wood of *A. mangium* and *A. auriculiformis* have been found to be suitable for chips, pulp and paper, plywood and fibre board (Pinso and Nasi, 1991). *Acacia mangium* is finding wide acceptance as a plantation species in peninsular India because of its fast growth and good form with a well defined relatively straight bole. Very little information is available on the growth and wood characteristics of these species at different locations in India. This paper summarises the results of the studies made on plantations of 3 species namely *Acacia auriculiformis, A. mangium* and *A. crassicarpa* established in Maharashtra by the Forest Development Corporation of Maharashtra (FDCM).

Material and Methods

Nine year old trees of *A. mangium* and *A. crassicarpa*, fifteen year old trees of *A. auriculiformis* and three year old trees of *A. mangium* introduced at Wada, Maharashtra (lateritic soil, 1500 mm rainfall) and raised by the FDCM in linear rows (spacing of 2m x 2m) were evaluated for the growth and morphological characteristics and wood properties. The growth traits (height and diameter at breast height) and morphological traits namely phyllode index (ratio of phyllode length to width), rachis length and bark thickness were measured for all the trees using an altimeter, tree calliper and measuring tape. Increment core samples of 6 mm diameter were extracted from 10 trees each (pith to periphery) at breast height using an increment borer and carefully brought to the laboratory for studying the wood characteristics (Varghese *et al.*, 1995). The wood samples were macerated and vessel and fibre dimensions were recorded using a calibrated ocular micrometer. Three anatomical indices namely Runkel ratio, fibre slenderness ratio and flexibility coefficient were computed to study the suitability of the species for paper making.

Results

Growth and morphological traits : At nine years of age *Acacia mangium* had comparable height and diameter as the fifteen year old trees of *A. auriculiformis* (Table 1). *Acacia crassicarpa* on the other hand put on almost equal height but the diameter growth was less and on par with the younger trees of *A. mangium*. Phyllode index and rachis length are two morphological traits that are rather specific to the seedlots of each species and less influenced by the age of the tree. *Acacia mangium* and *Acacia crassicarpa* had lower phyllode indices (less than 4) and longer rachis (more than 1 cm) than *Acacia auriculiformis*. Bark thickness on the other hand was seen to be influenced by age (significantly higher in older trees of *A. mangium*) and varying with species. *A. crassicarpa* and *A. auriculiformis* had intermediary values for bark thickness.

Wood characteristics : *A. auriculiformis* trees had the highest wood density followed by *A. mangium* (9 year old trees) and *A. crassicarpa* (Table 2). The young *A. mangium* trees had the lowest wood density. Sapwood percentage followed a similar opposite trend with the lowest values for *A. auriculiformis* followed by the large *A. mangium* trees. *A. crassicarpa* and small *A. mangium* trees had twice the sapwood percentage as that of the nine year old trees of the same species.

Fibre dimensions were seen to vary with the species. Fibre length, fibre width and fibre lumen width had the same trend with *A. crassicarpa* having long and wide fibres progressively decreasing in *Acacia mangium* (older trees) and *Acacia auriculiformis*. Fibre wall thickness was highest in the bigger *A. mangium* trees and significantly lower in the other two species. Age of the tree was seen to influence the mechanical tissues more than the vascular tissues as seen in the younger trees of *A. mangium*. These trees had short and wide fibres with wide lumen and narrow walls and slightly narrower and shorter vessel elements than the older trees. *A. crassicarpa* had large vessel elements followed by

Table 1

Growth and morphological traits of Acacia species

Species	Age (yrs.)	Height (m)	DBH (cm)	Phyllode index	Rachis length (cm)	Bark thickness (cm)
1. *A. mangium* (Am1)	9	20.6 b	27.91 b	3.30 a	1.20 b	0.92 c
2. *A. mangium* (Am2)	3	12.0 a	15.73 a	3.44 a	1.22 b	0.56 a
3. *A. crassicarpa* (Ac)	9	20.1 b	17.68 a	3.82 a	1.06 b	0.72 b
4. *A. auriculiformis* (Aa)	15	19.2 b	25.81 b	5.47 b	0.60 a	0.70 b

Values sharing common letter do not differ significantly at $P = 0.05$

Table 2

Wood traits of Acacia species

Species	WD (g/cm^3)	SW (%)	FL (µ)	VEL (µ)	VD (µ)	FW (µ)	FLW (µ)	DWT (µ)	RR	FSR	FC
Am1	0.529 bc	10.11 b	1062 b	294.7 a	215.6 b	18.32 b	9.80 ab	8.55 c	0.88 c	58.33 bc	0.53 a
Am2	0.417 a	24.66 c	938.6 a	264.7 a	185.5 ab	20.91 c	14.90 c	6.00 a	0.42 a	45.42 a	0.71 c
Ac	0.468 ab	22.74 c	1196 c	379.4 b	181.8 ab	19.20 bc	11.87 b	7.34 b	0.62 b	62.40 c	0.62 b
Aa	0.593 c	3.51 a	882.4 a	269.8 a	166.6 a	16.10 a	8.97 a	7.17 b	0.80 c	54.80 b	0.56 a

WD - Wood density, SW - sap wood %, FL - fibre length, VEL - vessel element length,
VD - vessel diameter, FW - fibre width, FLW - fibre lumen width, DWT - double wall thickness,
RR - Runkel ratio, FSR - fibre slenderness ratio, FC - flexibility coefficient
Values sharing common letter do not differ significantly at $P = 0.05$

Acacia mangium and *A. auriculiformis*, *Acacia crassicarpa* had lower Runkel ratio and higher values for fibre slenderness ratio and flexibility coefficient compared to the other species. The young *A. mangium* trees had significantly lower values for Runkel ratio and fibre slenderness ratio but high values for flexibility coefficient compared to the other species.

Discussion

Acacia auriculiformis is adaptable to different soil and climatic conditions and is used as a social forestry species. *A. mangium* and *A. crassicarpa* are more sensitive to site conditions and prefer high rainfall and low soil pH. At Wada both the introduced species are found to perform well. Both species have good form and have put on height on par with the fifteen year old trees of *A. auriculiformis*. The rainfall quantum as well as the distribution pattern have a major role in the growth of these species. Locations having long dry spells (more than six months) and strong winds are not suited (Matheson and Harwood, 1997) though there have been reports of *A. mangium* being fairly drought tolerant withstanding upto seven dry months (Midgley and Vivekanandan, 1987). The west coast of Peninsular India has been identified as having suitable climatic conditions for *A. mangium* (Booth and Hong, 1991) and the performance of the species at Wada confirms it. Liang and Gan (1991) reported reduced growth of *A. mangium* on poor sites and the superiority of *A. crassicarpa* over other species of Acacias at Sabah, Malaysia. However, trials in Vietnam with one seedlot each of four major Acacias showed *A. mangium* to be superior over the other species (Kha and Nghia, 1991).

Phyllode index and rachis length are rather fixed for a species but have a range of values across seedlots of different origin. Kha (1996) used phyllode index as a tool for identifying interspecific hybrids (having intermediate values, 3.09 - 3.37) between *A. mangium* (low values, 2.73 - 2.79) and *A. auriculiformis* (high value, 5.23 - 6.69). The indices obtained for *A. mangium* in the present study (3.3 and 3.44) are higher than reported in the latter study on one seedlot each of the two species and as high as that reported for the hybrids. Detailed studies on larger of individuals and seedlots will be necessary to find the range of values for a species. Rachis length also varied in *A. auriculiformis* (markedly shorter rachis) as observed in an earlier study (Varghese *et al.*, 1997). Bark thickness is influenced by the age of the tree and may vary between the different seedlots of a species.

Acacia auriculiformis had the highest density and the lowest sapwood percentage followed by the nine year old trees of *A. mangium* and hence useful as small timber and for building purposes (Kumar *et al.*, 1987; Razali and Hamami, 1993). Wood density is reported to vary drastically with location and age of the tree (Clark *et al.*, 1991) and positively correlated with diameter growth (Liang and Gan, 1991). The wood density values obtained for both *A. mangium* and *A. auriculiformis* are higher than those reported for 9-10 year old plantation grown trees at Sabah, Malaysia (Logan and Balodis, 1982) and similar to the value reported in 12 year old trees of *A. mangium* by Razali and Hamami (1993). The younger trees of *A. mangium* however had wood density values similar to those reported by Kha (1996) from Vietnam. *Acacia crassicarpa* had the lowest wood density which may be due to its low diameter growth.

All the three species of Acacias are suitable for pulping and can be used for a wide range of end products (Clark *et al.*, 1991). the four seedlots studied had Runkel ratios below 1 indicating their suitability for pulping. The fibre lumen width values obtained for *A. mangium* in the present study were low and hence Runkel ratio was high compared to the values reported (Runkel ratio = 0.32-0.34) by Razali and Hamami (1993). *A. crassicarpa* had long fibres, low Runkel ratio, high fibre slenderness ratio and flexibility coefficient compared to the other species. This species has pulping properties comparable to *A. mangium* and *A. auriculiformis* and differences are also reported between provenances (Thomson, 1994).

These introduced species may find increased acceptance for afforesting wastelands and degraded areas in the Western coast and it is desirable to test larger number of seedlots of these species in different agroclimatic regions to study the performance and suitability for various enduses.

Acknowledgements

The authors express their sincere thanks to the officials of Thane region and Thane Project Division of Forest Development Corporation of Maharashtra Limited for assistance in collection of data and wood samples.

SUMMARY

***Acacia auriculiformis* is one of the Australian *Acacia* species introduced in India for afforesting degraded lands, meeting fuelwood needs and as avenue trees. This species has been raised in the Western Ghats areas of Maharashtra and found to be very successful. Efforts were made to introduce *A. mangium* and *A. crassicarpa* by procuring seeds from Australia and Thailand. Growth performance and wood characteristics were studied in *A. mangium*, *A. auriculiformis* and *A. crassicarpa* planted in Thane District of Maharashtra. *A. mangium* had better growth than *A. auriculiformis* and *A. crassicarpa*. *A. auriculiformis* had higher wood**

density and phyllode index than the other species and *A. crassicarpa* had long fibres and vessel elements. Since *A. mangium* is being increasingly planted in tropical countries, multi-locational trials need to be raised in high rainfall areas in India to select the best performing seedlots.

ठाणे, महाराष्ट्र में लगाए *अकेसिया मैंगियम*, *अ० औरिकुलिफार्मिस* और *अ० क्रैसिकार्पा* के रोपवनों की वृद्धि और लकड़ी के लक्षण

मोहन वर्घिस, ए० निकोडेमस व के० सुब्रमनियन

सारांश

व्याहसित भूमियों के पुनर्वनीकरण के लिए ईधनकाष्ठ की जरूरतें पूरी करने और पंक्तिवृक्षों की तरह काम में लाने के लिए भारत में लगाने को आस्ट्रेलिया से मंगाई *अकेसिया* जातियों में एक जाति *अकेसिया औरिकुलिफार्मिस* भी है । यह जाति पश्चिमी घाट क्षेत्रों में उगाई गई हैं और वहाँ बड़ी सफल रही है । अब आस्ट्रेलिया और थाई देश से *अ० मैंगियम* और *अ० क्रैसिकार्पा* के बीज मंगाकर उन्हें यहाँ लगाने के प्रयत्न किए जा रहे हैं 1 महाराष्ट्र के ठाणे जिले में लगाए गए *अ० मैंगियम*, *अ० औरिकुलिफार्मिस* और *अ० क्रैसिकार्पा* की वृद्धि सक्रियता और काष्ठ विशेषताओं का अध्ययन किया गया है । *अ० मैंगियम* की बढ़वार ज्यादा अच्छी है । बनिस्पत *अ० औरिकुलिफार्मिस* और *अ० क्रैसिकार्पा* के *अ० औरिकुलिफार्मिस* में काष्ठ घनत्व और पत्रावरण निर्देशांक अन्य जातियों की अपेक्षा श्रेष्ठतर हैं तथा *अ० क्रैसिकार्पा* का लम्बा रेशा और वाहिनी तत्व अधिक अच्छे हैं । चूंकि *अ० मैंगियम* उष्णदेशों में ज्यादा ही लगाया जा रहा है, इसलिए सर्वोत्तम सक्रिया देने वाले बीज खण्डों का चुनाव करने के लिए भारत में अधिक वर्षा होने वाले क्षेत्रों में उगाकर देखने के लिए बहुस्थानीय परीक्षण कराने की आवश्यकता है ।

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RESEARCH NOTES
(I)

NURSERY TRIAL OF *ABIES PINDROW* SPACH. (SILVER FIR) IN BATOTE

Introduction

Silver fir (*Abies pindrow*, Spach) is a tall evergreen conifer tree found in temperate forests. The trees have dense conical crown of dark green foliage which frequently extends throughout the Western Himalaya from Afghanistan to Nepal chiefly at 2100 m and prefers cool, moist areas with deep rich soil, commonly on the northern aspect and sheltered depressions. Normally it is found mixed with *Picea smithiana* and both of these together constitute about half of the coniferous growing stock. There are certain localities where *A. pindrow* forms pure forests or is mixed with *Cedrus deodara*/or *Pinus wallichaina* or broad-leaved species.

Abies pindrow is an important species of Batote Forest Division and is found in all the territorial ranges but the natural regeneration is almost absent here too. Absence or very poor natural regeneration in fir forests has been found due to many factors such as :

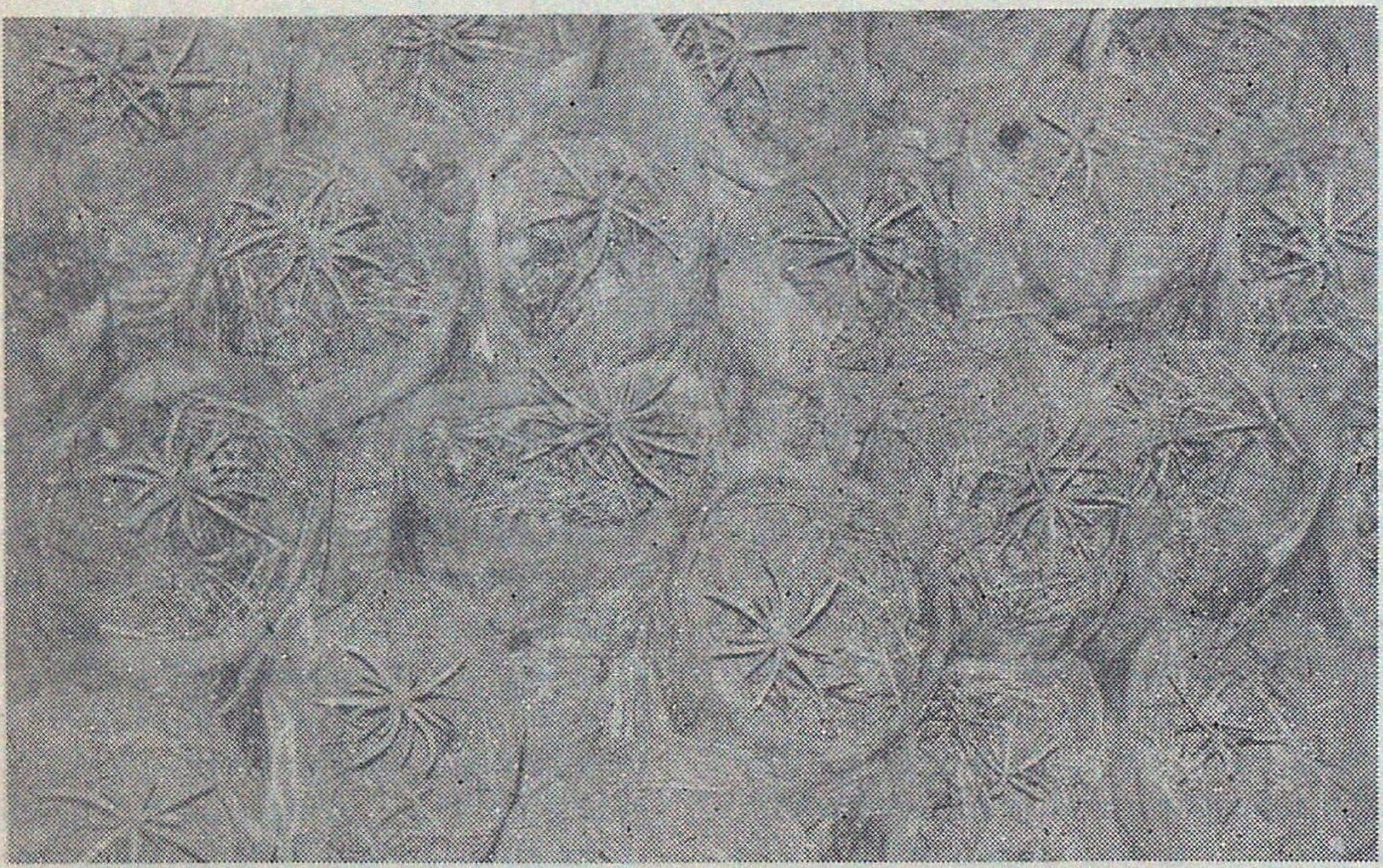
- Over mature and very old trees.
- Accumulation of raw undecomposed acidic humus.
- Excessive herb and shrub growth.
- Debris accumulation.
- Exposure to hot sun.
- Poor seed production/germination.
- Heavy grazing/biotic pressure from migratory as well as local livestock.

Fir forests like other coniferous forest have been exploited for timber in the past. The exploitation of these forests coupled with heavy grazing resulted in big blanks where natural regeneration failed to come in the years to follow. The seed bearers which were left in compartments could not give the desired results. Moreover, every year is not a good seed year for Fir, which may be expected about once in every 3 to 4 years. Further, no attempt has been made in the Division and for that matter in whole of Chenab valley where the species grows, for its artificial regeneration by raising the seedlings in the nurseries in the initial years. A trial to raise the seedlings from the locally collected seed was done in the Division in the year 1996.

Material and Methods

Compartment 19 of Batote Forest Division is short of Sanasar and is located on the either side of Patnitop-Sanasar road. It has very old and sparse crop of Fir with mostly over-mature trees. The area is badly degraded as natural regeneration of Fir is altogether absent and whatsoever trees of Fir are present, are either rotten at the base or broken from the top. Very few healthy trees are found in the Compartment. In 1996 during one of the inspections some trees were found bearing cones. The ripened cones were removed from trees in first week of October by hand. The bracts of the cones were intact and

Fig. 1



16 month old *Abies pindrow* seedlings at Forest Rest House, Patnitop

closed. The cones were kept in sun for a few days for drying. With the drying the bracts started opening, shedding the seeds. The seeds were separated from the scales by shaking the cones. The seed collected thus was cleaned by winnowing etc. and kept in cool dry and airy place for almost two months. In December 1996 the seed was sown as such without any treatment in polybags kept at three different locations viz. 500 Polybags in the lawn of DFO's residence Batote (Alt. 1820 m), 1000 bags in the backyard of Forest Rest House Patnitop (Alt. 2100 m) and 1000 bags in the backyard of FRH Sanasar (Alt. 2050 m). The polybags of the size 22 cm x 10 cm were filled with humus collected from the nearby forest floor itself and 2-3 seeds of Fir were sown in each bag about 15 mm deep between 15th to 20th December. First snowfall of winter took place on 17th January 1997 and thereafter there were several snowfalls and as a result the polybags remained under the cover of snow till March 1997.

Results

The germination of Silver fir seeds in polybags started in May 1997 and continued till June. The germination was epigeous with more than 80% germination percentage. In all the three locations of trial, the germination of Fir seed was equally good and successful. The height of approx. 16 month old seedlings is 10-12 cm. No special care of seedlings has been taken so far except weeding and watering whenever required and the seedlings are doing extremely well. This trial has proved that the whatsoever number of Fir trees are available in the area, are viable seed bearers and can be used as seed source for establishing Fir Nursery in Batote Division and elsewhere for carrying out artificial regeneration in degraded Fir Compartments of the Division.

Conclusion

Keeping in view the present status of Fir forests of the Division where natural regeneration is totally absent, the artificial regeneration by way of raising seedlings in nurseries and subsequently planting in the field after 4 to 4½ years care in the nurseries to replenish the degraded forests needs to be adopted.

Divisional Forest Officer,
Udhampur Forest Division,
Udhampur (J&K)

Ravi Kumar Kesar

(II)

PERFORMANCE OF *PHYLLOSTACHYS PUBESCENS* IN ARUNACHAL PRADESH

Phyllostachys pubescens is a non-clump forming monopodial bamboo naturally found in China and Japan. The species establishes and spreads itself through a network of subterranean rhizomes sending out erect culms at frequent intervals. It is known for its utility for edible shoots, construction material and for soil conservation purposes. The species is the main source of edible bamboo in Japan. The shoots are crisp in structure and without pronounced acidity (Sharma, 1980). In Korea it is reported that about 10,000 kg shoots could be obtained from one hectare of intensively managed plot. The yield could be enhanced by application of 375 kg of NPK per hectare (1:1:1) as reported from China (Maoyi *et al.*, 1988). Such fertilizer application is best done one month before the emergence of new shoots. The chips of this species can also be converted to a straw substitute suitable for use as fodder through special treatments. The agro-climatic conditions required for this multipurpose bamboo could be found in the subtropical zones of Arunachal Pradesh. A related species (*Phyllostachys bambusoides*) is naturally found and grown in the State in abundance.

Judging from the profitability of the species and its adaptability to Arunachal Pradesh a few seedlings were obtained from the FRI, Dehra Dun for preparation of planting stock and experimental planting. A few seedlings were planted at Chessa (altitude 162 m) in Papum Pare District. The planting site here is more or less plain, soil sandy loam, temperature ranging to a maximum of 38°C during summer and a minimum of 9°C in winter with an annual rainfall of around 2500 mm. However, all plants died here. Simultaneously seedlings were also planted at Yachuli, a small township in the Lower Subansiri district during February 1995. The altitude of this place is about 1000 m and the beautiful *Pinus kesiya* plantations surround the area. The planting site is a small hillock, soil laterite, the minimum temperature during winter months is around 4°C, and mean annual rainfall is 2300 mm with June, July and August are the peak rainfall months.

The new culms emerge during spring from February to April. The initial growth of the culm is quite fast and the full height is attained within a month. A creamish-brown sheath surrounds the new culms. The individual sheath is 4 to 6 cm wide at the base and pointed at the tip (0.5 to 1.0 cm). A new culm was found to be surrounded by 9 to 10 pairs of the sheaths. The total length of the sheath is about 44 cm. The clump looks beautiful due to its monopodial nature and presence of a prominent white ring at each node. The culms are softly pubescent and velvety to touch. This is a quite fast growing species as it has occupied 80 m^2 area just in a period of 4 years. At present there are 211 culms and their number could have been greater had there been proper soil working and management. The increase in growing area during the current year's growth was about 20 m^2. The underground monopodial rhizomes spread very fast horizontally below the ground surface and help in the quick development of the clump. The rhizome consists of compressed internodes and closely spaced nodes from which the root develops. It is profusely covered with scales and has long creeping branches, which sends up tufts of culms all around the parent clump. The culms take about 3 to 4 years for maturity. It is a medium-sized hollow bamboo; the thickness of the culm is 7 to 9 mm at the base. Since bamboo has a very important role in the day to day life of the local people, this species can be very useful especially for the sub tropical and temperate areas of the State. The details of growth statistics are mentioned in Table 1.

Table 1

Growth statistics

(i) Total no. of culms	211
(ii) No. of new culms	
(a) 1998	63
(b) 1999	85
(iii) Av. height of culms (m)	12
(iv) Girth of the mature culms (cm)	
(a) at the base	18
(b) at breast height	15
(c) internodal length at the base	7
(d) internodal length at breast height	14
(v) Girth of new culms (cm)	
(a) at the base	10
(b) at breast height	8
(c) internodal length at the base	1-2
(d) internodal length at breast height	8
(vi) Height of the sheath (cm)	44

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State Forest Research Institute,
Itanagar (Arunachal Pradesh)

N.S. Bisht,
K. Haridasan
and
S.P. Ahlawat

(III)

A NEW DISEASE OF *TAXUS* FROM INDIA

During disease surveys in Uttar Pradesh and Jammu & Kashmir forests a new disease of *Taxus bacata* hitherto unrecorded on this host was detected. The causal organism has been identified as *Isthmiella abietis* (Dearn.) Darker, (= *Bifusella abietis* Dearn). The symptoms and the causal organism is described here as it occurs on *T. bacata*.

Initial symptoms include appearance of chlorotic areas on infected needles followed by development of black, linear fruit bodies on the midrib of the needles (Fig. 1). Infected needles subsequently turned yellow and fall off prematurely. The fruit bodies of the fungus developed after two years of infection as observed on young *Taxus* plants in Chakrata Forest Division, Uttar Pradesh.

Hysterothecia hypophyllous, continuous along the midrib, black subepidermal (Fig.2). Asci clavate, thin walled, rounded at the tip, 28-98 x 10-28µm; paraphyses filiform, septate, slightly swollen at the tip, 25-80 x 1-2µm. Ascospores, eight per ascus, bifusiform, one celled, hyaline with thick gelatinous sheet, 42-52 x 5-6µm. Herb (DIS) Pathology-543.

I. abietis was also recorded on needles of *Abies pindrow* from India (Misra and Sehgal, 1989) the fungus has a two year life cycle, i.e. it takes two years from infection to production of ascospores, resulting in alternate years needles being infected, since only new needles are susceptible.

Fig. 1-2

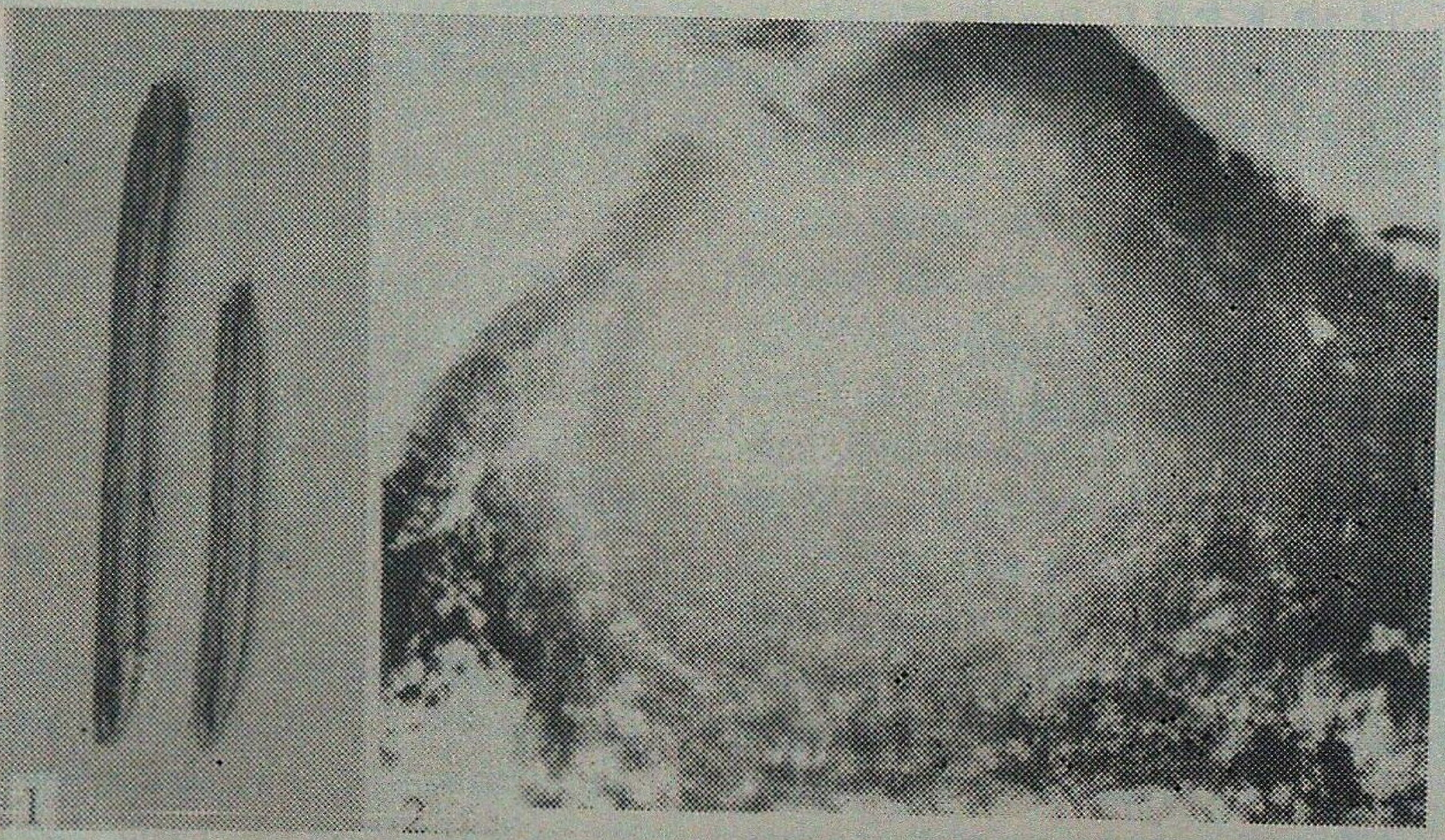

Fig. 1 - Hysterothecium on midrib of *Taxus* needles.
Fig. 2 - Cross section of hysterothecium showing asci and paraphyses

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Forest Pathology Division,
Forest Research Institute,
Dehra Dun (U.P.)

B.M. Misra
and
S.N. Khan

NEWS AND NOTES

An International Symposium on "Tropical Forestry Research : Challenges in the New Millennium" is being organised by the Kerala Forest Research Institute (KFRI) on the occasion of the Silver Jubilee of the Institute. The Symposium will be held from 2-4 August 2000 at KFRI.

For further details, contact : Shri J.K. Sharma, Director, Kerala Forest Research Institute, Peechi - 680 653, District Thrissur, Kerala, India.

From the Indian Forester - One Hundred Years Ago

THE
INDIAN FORESTER
September, 1899 (p. 380)

ARBORICULTURAL EXPERIMENTS

It would be a great satisfaction to some who formerly worked in India, and perhaps not without use to others, if we occasionally heard of the present results of experiments which were started some years ago, and which it is difficult to believe have altogether died out and left no mark.

Among the experiments made to introduce particular trees and plants into India, many of course have been failures, and sometimes costly failures, because they were tried without the least *a priori* chance of success. We used to be sent wondrous bags of seeds in the Punjab and told to make plantations of them. I recollect having been given a piece of wretched dry soil filled with old brick debris and saturated with sulphate of soda and being desired to plant it with the "Carob tree". Of course the thing failed the wonder being, that about half-a-dozen Carob trees were actually got to grow in places where water could be given ! But the dry climate of the Punjab plains will never allow the Carob to develop its fruit. Another experiment was, however, made with better prospects and that it would be extremely interesting to hear of, if any results have survived. It was known that the edible chestnut grew in Dehra Dun and the hills beyond, and an effort was made in the Sutlej valley (and I think in Kulu and elsewhere) to grow it, as the fruit would be a very real resource to the forest population during the long winters. I know that 20 years ago there were a few flourishing chestnut groves in Bussahir. Has the edible or 'Spanish' chestnut been at all successful ? Once more; we tried the olive also. Even in the Punjab plains, the (South) French and Italian olive grew and flowered. In my garden, on alluvial and good soil in the older part of Lahore, I had a tree (I think from Italy or South France) which in February-March flowered freely and produced little olives, the size of a pea; but instead of developing the hot winds of April-May dried them; they turned yellow and fell off. We then conceived the idea that the tree would fruit in the lower hills, say Chamba or Kulu, where there is an indigenous, wild species, and in the Agro-Horticultural gardens at Lahore many indigenous olives were raised and grafted with the fruit-bearing species, and the plants were sent to the hills. Grafted plants imported direct from Europe were also obtained (from Messrs. Andrieux and Vilmorin) and sent to Kulu. Has any result been obtained ? An olive tree does not, I believe, fruit for several years, but what I speak of was done about 15 or 20 years ago.

We also introduced the English oak and beech and actually had some young trees at Kalatop forest (and elsewhere) near Dalhousie; this was more for ornament than with the hope of economic utility, but it would be interesting to know whether any trees survive ? There used to be a tree of *Q. robur* (or *pedunculata*, I forget which) at Abbotabad in Hazara.

- B.H. Baden-Powell

LETTERS TO THE EDITOR
(I)

To
The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Sub : ***Monitoring of genetic stock and quality of Poplar ETPs raised in private nurseries for Agro/Farm-forestry Plantations***

Sir,

With your kind co-operation I would like to bring the following issue to the notice of the State Forest Departments of India.

Introduction of Poplar (*Populus* spp.) as an Agro-forestry species in the States of Haryana, Punjab and Western Uttar Pradesh has undergone three distinct phases. Initially (in 1970s and mid 1980s) the farmers were hesitant and sceptical in adopting the cultivation of Poplars on their farmlands. However, the government plantations demonstrated that Poplar having shorter rotation (5-8 years) can be grown successfully in combination with many agricultural and cash crops without substantially reducing the yield of such crops. This demonstration motivated large progressive and absentee farmers for growing Poplars on their farmlands. The development of Poplar based industries such as plywood, pencil making, packaging boxes, a sound market system and the depression of *Eucalyptus* market prices in the 1980s resulted in switching over from *Eucalyptus* to Poplar plantation by majority of farmers in these States. In the recent past the practice of cultivation of Poplars in private farms under Agro-forestry has become a passion even with small and marginal farmers who saw it as a potential source of additional income. Consequently one comes across a mosaic of large blocks of Poplar plantations (2,000 to 10,000 trees) and smaller plantations raised as boundary rows (50-100 trees) scattered over an otherwise agricultural dominant landscape.

Initially, the Poplar ETPs (entire transplants) for supply to farmers were raised only in the government nurseries by the State Forest Departments. However, these government nurseries have failed to cope up with the recent higher demands of ETPs. Eventually many private nurseries have started raising Poplar ETPs. Since, these nurseries are run with the sole intention of profit making, little attention is being paid to maintain the quality of ETPs. Very often the propagules are collected from lower branches of nearest tree to raise ETPs. Therefore, plagiotropism (topophysis effect) is clearly visible in the younger trees (2-3 yrs old) of Poplar in many plantations in the States of Haryana, Punjab and Western U.P. Moreover, the genetic information of these ETPs such as clone number, etc., is also unknown. No seed certification system similar to one in operation for agricultural crops is prevalent for trees. Consequently, many Poplar clones have been introduced in the last decade without proper large scale testing in field conditions.

Out-planting of a large number of such inferior ETPs is likely to result into deterioration of quality of timber produced from these plantations and subsequent reduction in average yield ha^{-1}, thereby resulting in reduction of price of such inferior timber, which may lead to loss in interest amongst the farmer for Poplar cultivation. The burden of this negligence of private nursery owners and ignorance of poor farmers would be borne by the Forest Departments. Therefore, a regulation mechanism to monitor/control the quality of ETPs is a pertinent and important issue.

Most farmers consider higher height and greater stem thickness as desired criteria of a healthy ETP. These growth attributes can be manipulated by nursery owners through fertilization and irrigation irrespective of the genetic nature and physical source of propagule (branch cutting). Consequently all ETPs (one year old) look alike and the phenotypic characterization of such leafless ETPs for quality control (parameters) is very difficult and rather impossible. It is also true that many progressive farmers have realized the importance of superior ETPs and are raising their own stock for personal use. Hence, the small and marginal farmers comprise the group most affected by planting of inferior ETPs. These sections of land tillers can not afford to raise their own planting stock due to financial constraints, and therefore, would continue to depend on government/private nurseries for ETPs.

It can be argued that in the absence of an act and regulation mechanism it is not possible to regulate and monitor the quality of ETPs raised in private nurseries. However, the State Forest Departments may possibly check the spread of the inferior ETPs to farmers' fields in two possible ways. The Forest Departments have well established and strong publicity and extension wings. The services of these extension divisions can be utilised to increased awareness amongst farmers about the importance of superior ETPs for ensuring higher yields and economic returns in future. The publicity division should publish suitably illustrated (with pictures of branched and crooked trees resulting from transplanting of inferior ETPs and information on resultant loss in sale price of wood) brochures highlighting the disadvantages of planting inferior ETPs.

A beginning can be made to check further spread of inferior ETPs provided the State Forest Departments supplies cuttings of Poplar to private nursery owners. This could be followed by registration of some nurseries capable of producing ETPs in various Districts, and incentives can be given to owners for raising superior ETPs. It could be made mandatory for such private nurseries to obtain cuttings from Forest Department. These cuttings can also be supplied to decentralized Mahila/peoples' nurseries. The monitoring of a few registered nurseries is a feasible proposition as compared to inspection of a large number of smaller nurseries. Furthermore, the State Forest Departments can recommended to farmers to buy ETPs only from such nurseries that are included in a list published by the Department for each District. This endeavour will not only ensure the genetic identity and quality of Poplar ETPs but would also save Forest Departments from financial burden involved in raising large number of ETPs for distribution under Farm/Agro-forestry plantations.

Yours Sincerely,
Sd/- Dr. P.P. Bhojvaid, IFS
Conservator of Forests & Head, NWFP Division,
Forest Research Institute, Dehra Dun (U.P.)

(II)

To
Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Sub : **Wood for Domestic Fuel - A 'crisis'**

Dear Sir,

I have read with interest the article with the above caption by S.S. Chitwadgi I.F.S. (Retd.) appearing in your esteemed journal in its January 1999 issue. I would like to make the following observations :

1. The Government of Madhya Pradesh made some concessions for collection of firewood. The farmers are allowed to remove as firewood non-nationalised trees, whether grown by farmers or remained unfelled during cultivation or naturally grown in the fields. It appears that green and sound trees might also be removed. The correct procedure should have been to mark the removable trees (dead, dying, diseased, moribund ones) which are unfit for any other use except as firewood. These should have been in lots and quotations should have been invited and then disposed of accepting the highest offers. The Forest Department should see that no unmarked trees are removed. It appears from the writing of Shri Chitwadgi that old trees having no chance of survival have been left out. It can safely be presumed that young stands have already been removed, leaving the old ones "having outlived their times". This is against all Silvicultural Principles.

2. It appears there is unchecked smuggling of trees for firewood from roadside, protected and Unclassed State Forests (U.S.F.) day and night by way of headloads, trucks and tractors and trains too. I did not think that things were and are so bad in Madhya Pradesh, which has a total geographical area of 443,446 km^2 of which 131,195 km^2 are covered by forests (29.6 %). It is really a matter of great concern that Madhya Pradesh has lost 3,969 km^2 of forests between 1995 and 1997.

3. Shri Chitwadgi candidly admits that "which is brought as firewood is all from live trees made to die/dry skillfully to hoodwink everybody". This is indeed very sad. Unless this nefarious practice is put an end to, the already dwindling forest cover of Madhya Pradesh (the largest State in the Indian Union) will further dwindle making the lives of the people (mostly tribal) miserable, as they mostly depend on forests for their livelihood.

4. As suggested by the author, conditions adverse like fire, grazing, unauthorised collection of Non-Wood Forest Products (NWFP) have to be prevented.

5. Public awareness of using forests to the extent of their carrying capacity limits is to be created.

6. Shri Chitwadgi laments that "unless growing stock is known, extent of depletion can not be ascertained and the negligent booked". May it be assumed from this remark that there are no Working Plans for forests in Madhya Pradesh ? Depletion of forest cover will destroy the environment and increase pollution.

7. From what has been described by the author in his thought provoking article, it would appear that in Madhya Pradesh firewood scarcity has not provoked much attention. The villagers collect the firewood from the forest as a matter of their traditional right. Something must be done to streamline this old habit now when the condition has changed and fuel has become a crisis facing the country.

Yours faithfully,

Sd./- T.R. Mahanta I.F.S. (Retd.)
Choladhora Sashtripeeth
Jorhat (Assam)

OBITUARY

Smt. Anjana Dutt
(2-1-1959 - 15-7-1999)

The community of foresters has registered a shocking grief with the sudden demise of Smt. Anjana Dutt belonging to 1982 batch of Indian Forest Service, Uttar Pradesh Cadre on the morning of 15th July, 1999. As Project Director in Doon Valley Watershed Management Directorate, Derha Dun, she was visiting the Rainiwala village with a team of about 30 officers from 4 States working in Watershed Management. Dedicated to the cause of people's participation in natural resource management, she took her last breath pursuing her vision at the site where she collapsed on the day.

Anjana was born in Farrukhabad (U.P.) on 2nd January, 1959. She had a brilliant school record and secured Gold Medal for finishing first in M.Sc. in Botany from Lucknow University in 1980. She was selected in merit for 1982 batch of Indian Forest Service. All through her training at IFC, she added many a feather in her cap by performing excellently in sports, cultural and academic activities. She finished first once again in *inter-se* seniority of 1982 batch.

Anjana has left behind the unfulfilled task of institutionalizing participatory natural resource management in Uttrakhand. Starting her career in Uttar Pradesh from Nainital, she served in Almora and Dehra Dun districts as DFO Territorial; Civil Soyam and Project Director Watershed Management Directorate, respectively. Her innovative styles of involving people in the movement of natural resource management attracted the attention of one and all since 1986 when JFM was a little talked about issue. With strong professionalism and deep knowledge of technical forestry, she exhibited a remarkable knack of amalgamating the professional objectives with the priorities of the deprived classes. She also worked in Kanpur Social Forestry Division and Foresters Training Institute where her skills of HRD flourished. She had the opportunity to attend two training courses in UK where she excelled. She had represented India in meets at Miami and Bangkok and her presentations were applauded for being factual and authentic. The mass of people, who share her concerns for forestry development with people's welfare, is beyond a possible estimation. Her sensitive approach to the feelings of people as well as her administrative skills in handling tough or unforeseen situations, were superb. She commanded respect and affection from the people who had worked with her. An eloquent orator, she was listened carefully not only by her staff, but also by the people she incessantly worked for.

Anjana is survived by her husband and batch mate, Shri Anil Dutt, RGM, UPFDC, Dehra Dun and two daughters. She has left behind innumerable friends and admirers mourning her absence from amongst them. A few of her batch mates, who met her at Dehra Dun way back in 1982, had witnessed her final departure back in Dehra Dun in 1999. The family of foresters shares the grief and sorrow of the bereaved family Anjana has left behind.

May her soul rest in peace.

- Gopa Pandey

GAZETTE NOTIFICATIONS

TAMIL NADU GAZETTE

Dr. Sukhdev Thakur, IFS Managing Director, TANTEA, is transferred and posted as Chief Conservator of Forests (Forest Administration).

Shri A.S. Balanathan, IFS, Chief Conservator of Forests (Forest Administration), is transferred and posted as Chief Conservator of Forests (Planning and Development).

Shri R. Sundararaju, IFS, Chief Conservator of Forests (Social Forestry), is transferred and posted as Managing Director, TAFCORN, Tiruchi.

Shri Gautam Dey, IFS, Chief Conservator of Forests (Planning and Development), is transferred and posted as Chief Conservator of Forests (Social Forestry).

Shri K.S. Dehal, IFS, Managing Director, TAFCORN, Tiruchi, is transferred and posted as Managing Director, TANTEA.

Shri Sugato Dutt, IFS, Deputy Conservator of Forests, on repatriation to State from Wildlife Institute of India, is posted as Eco-Development Officer, Tirunelveli in the existing vacancy.

Shri Akash Deep Baruah, IFS, Deputy Conservator of Forests, on completion of training in Wildlife Management at Dehra Dun is posted as Deputy Conservator of Forests (Social Forestry) Publicity, Office of the PCCF, Chennai.

Shri Anurag Mishra, IFS, Dy. Conservator of Forests, on completion of his training in Remote Sensing at Dehra Dun is posted as Divisional Forest Officer, Afforestation, Tiruvannamalai vice Shri Syed Mustafa, IFS, DCF on leave.

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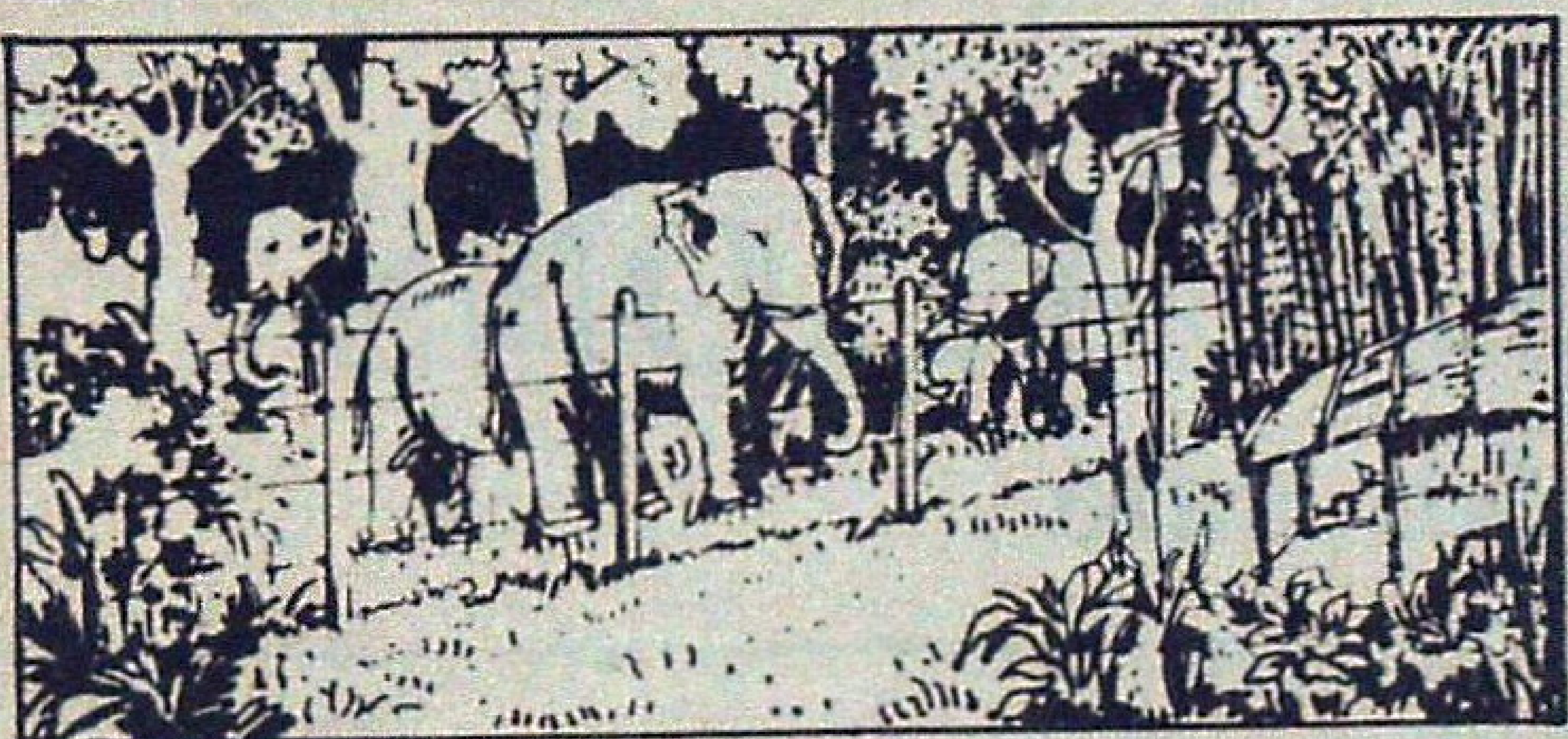

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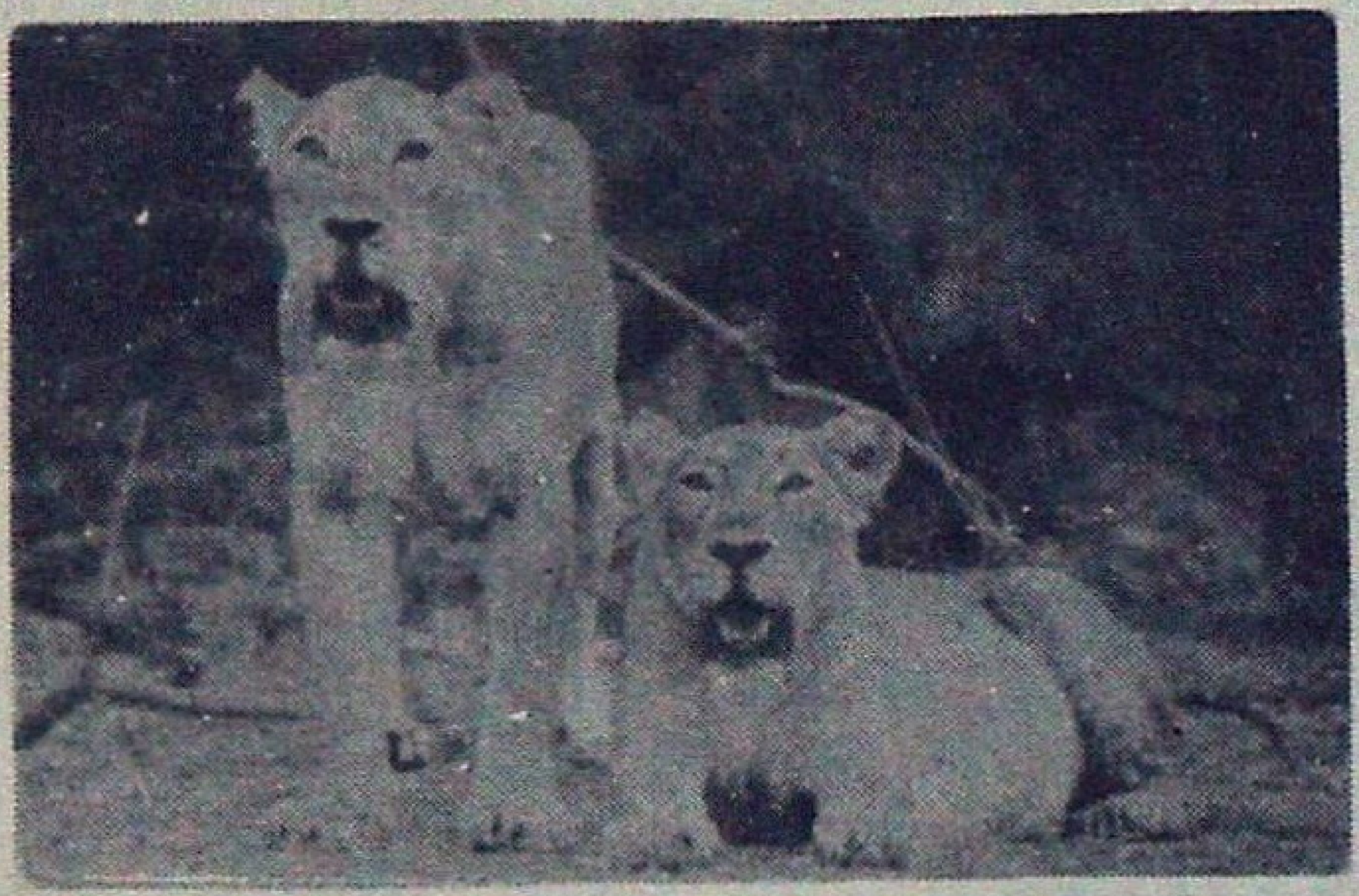

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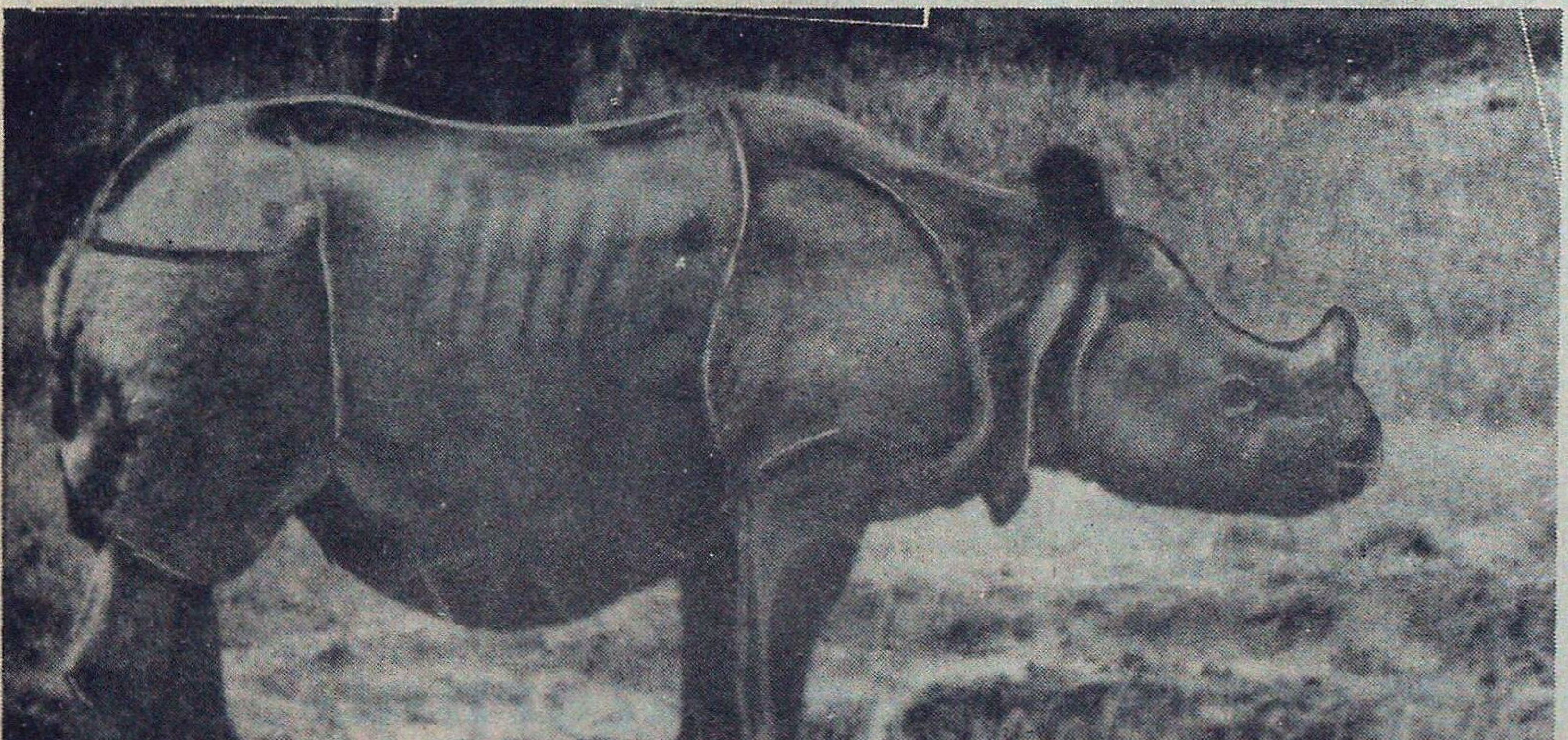

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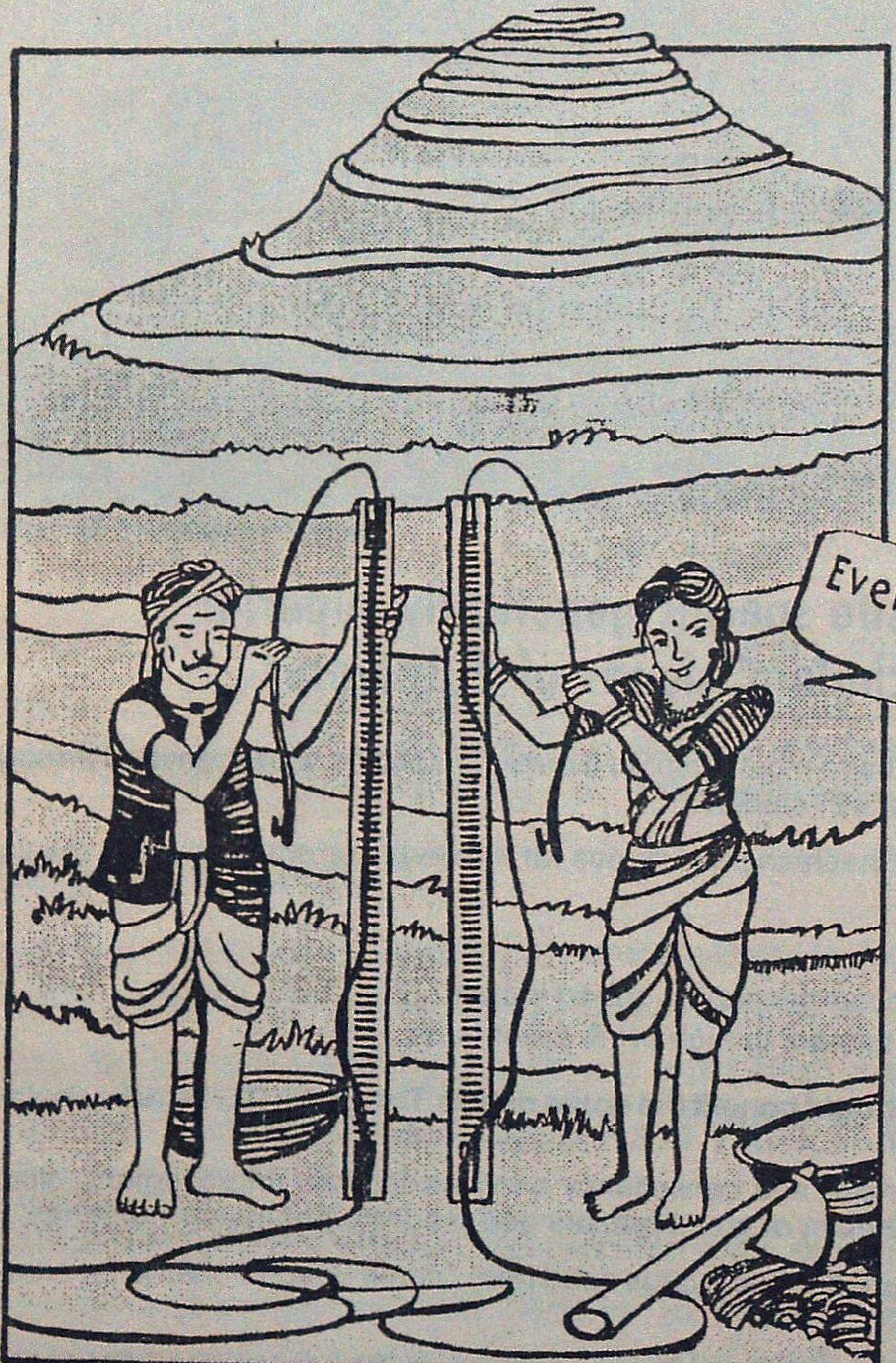

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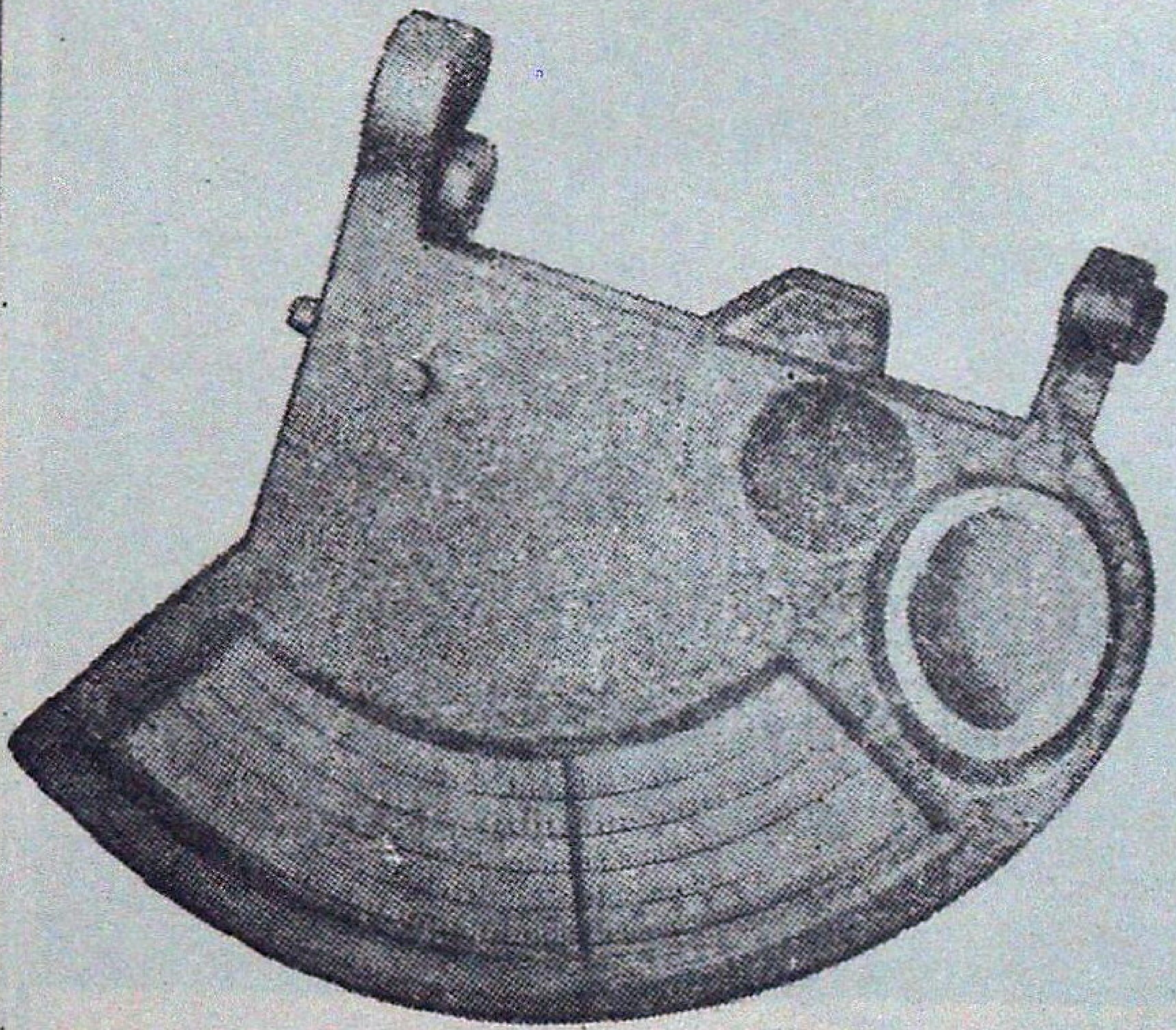

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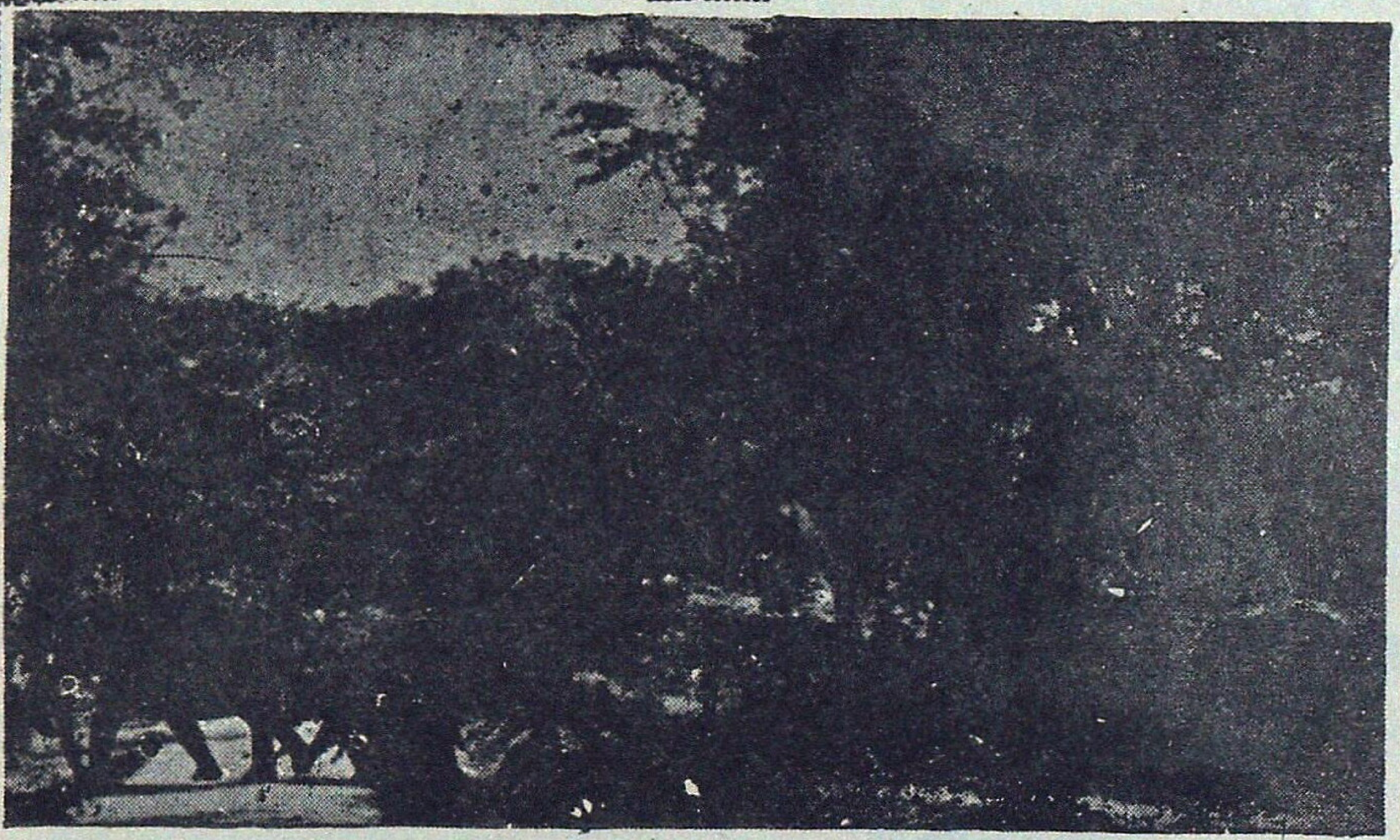

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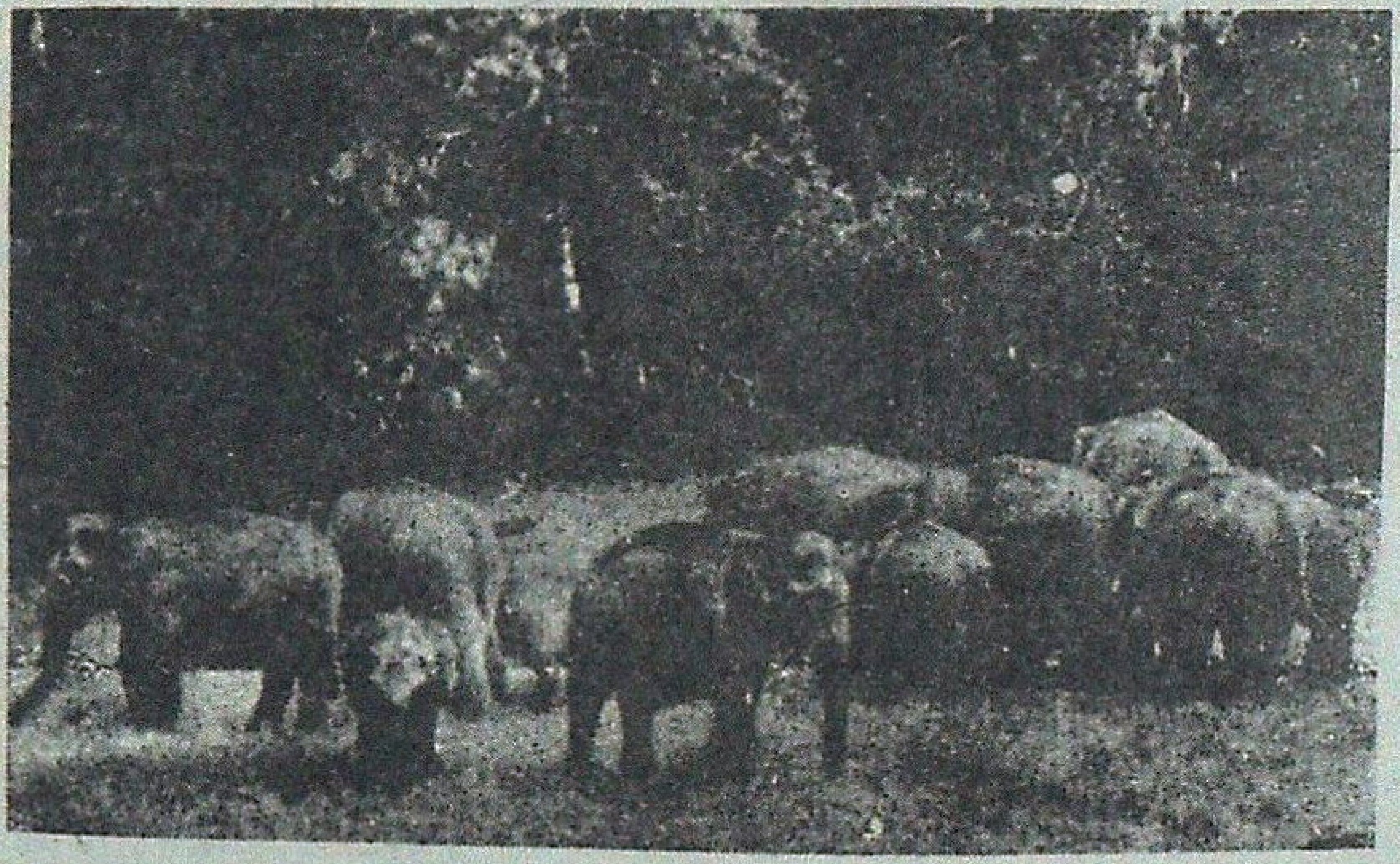

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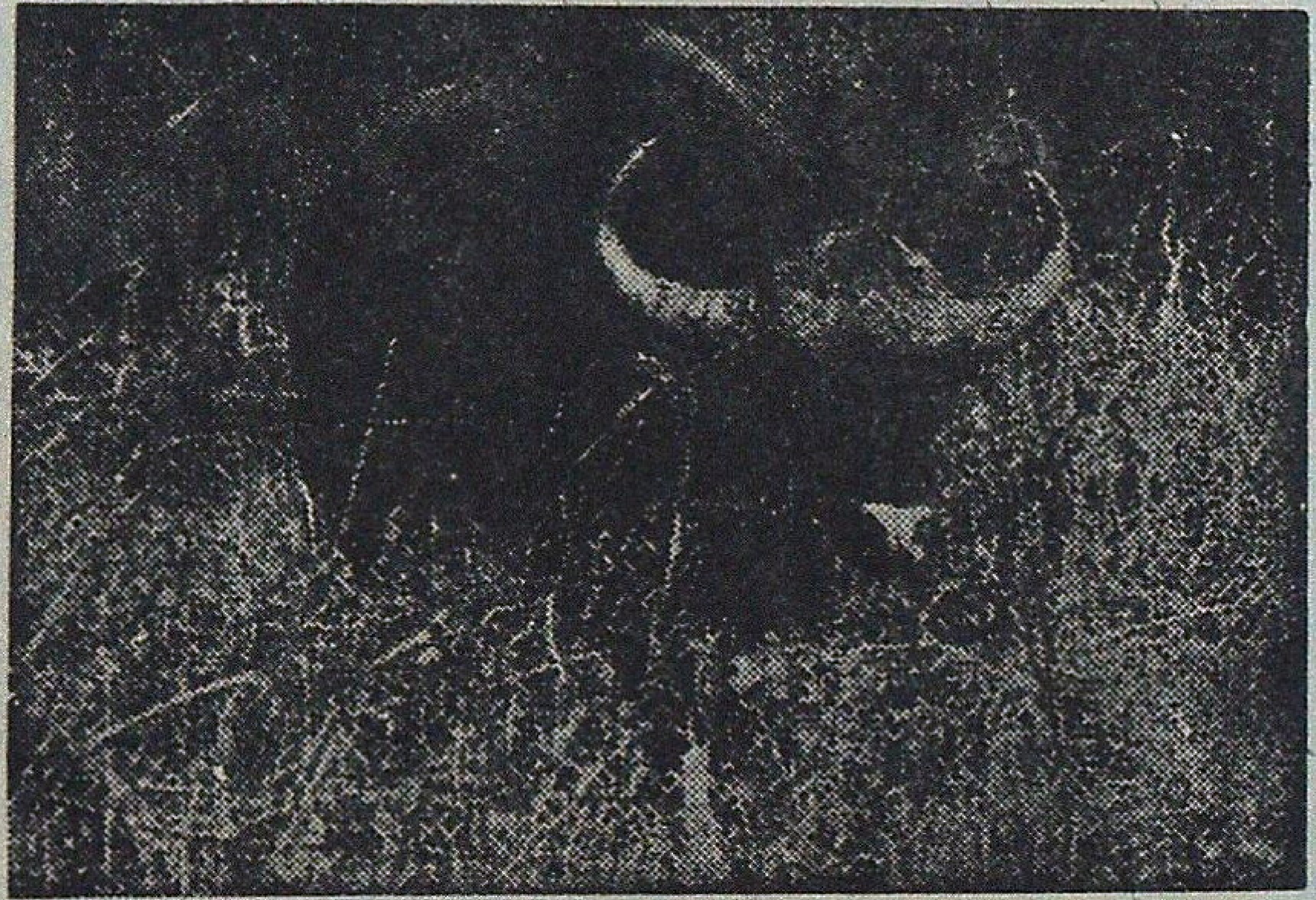

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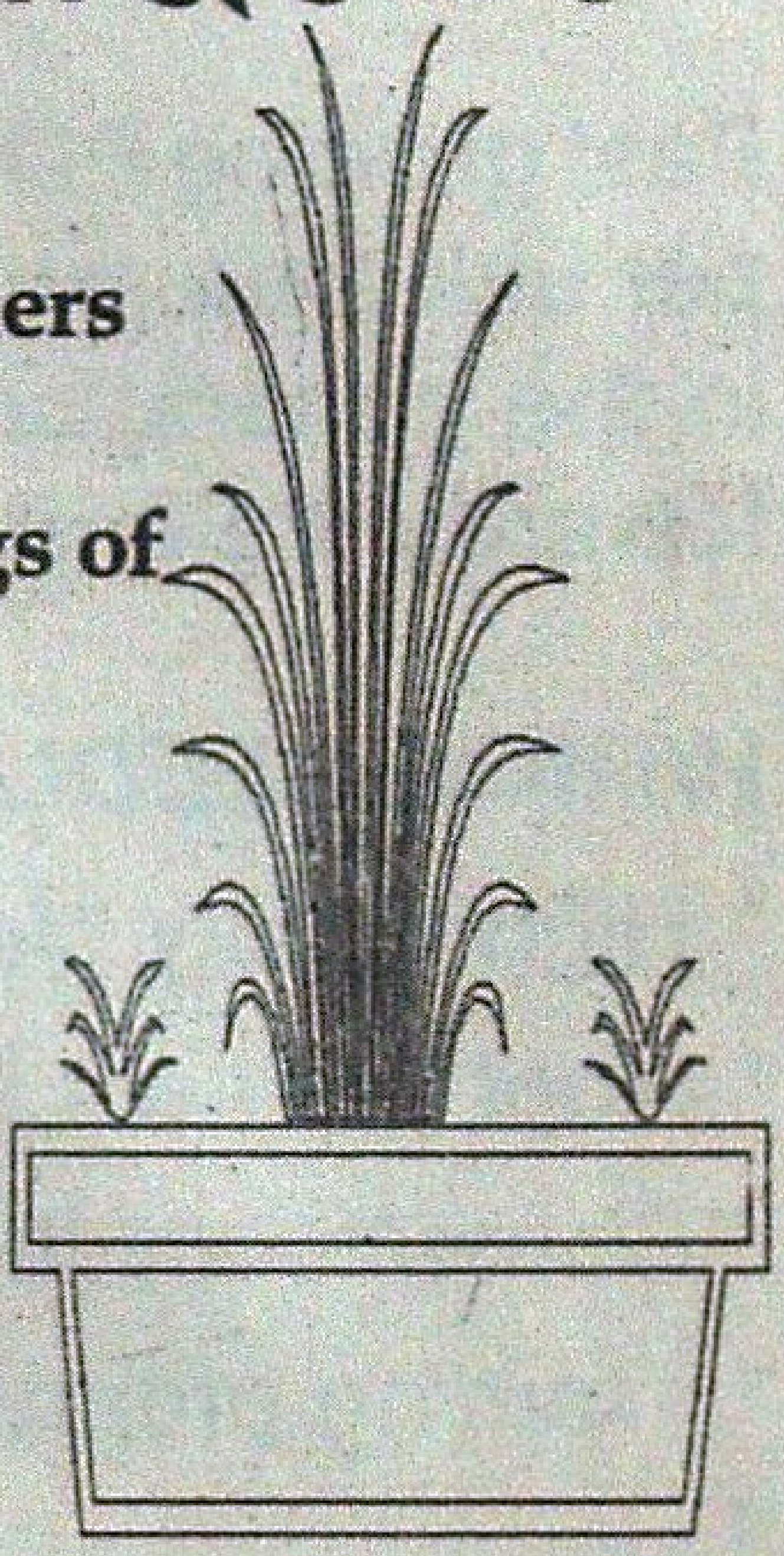

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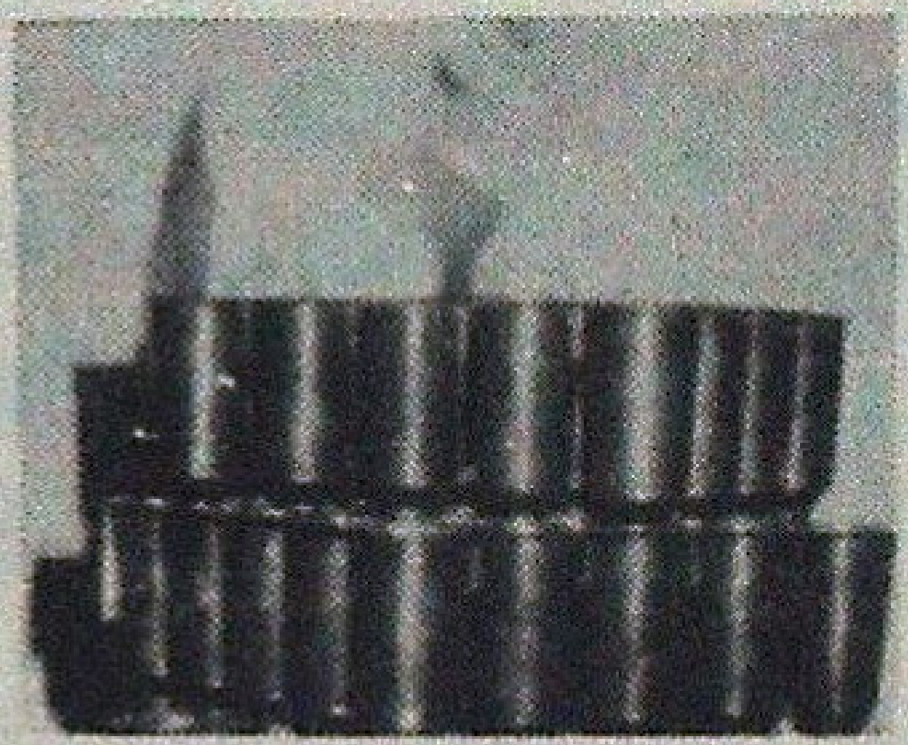

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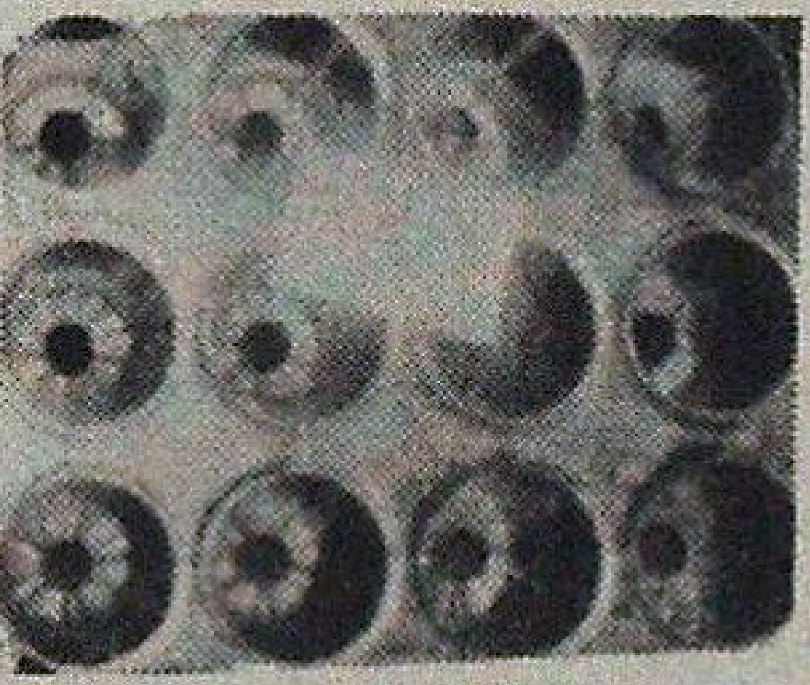

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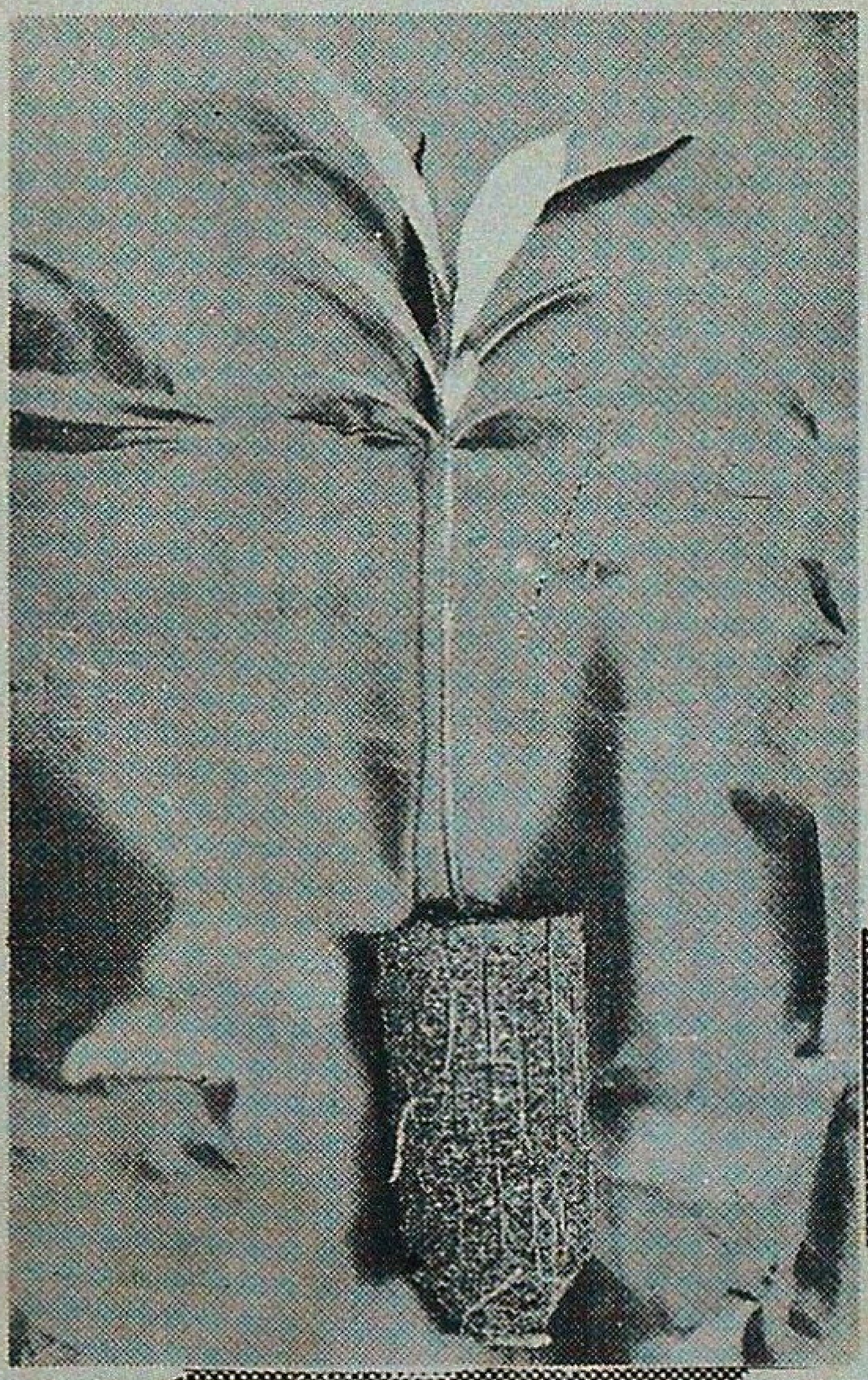

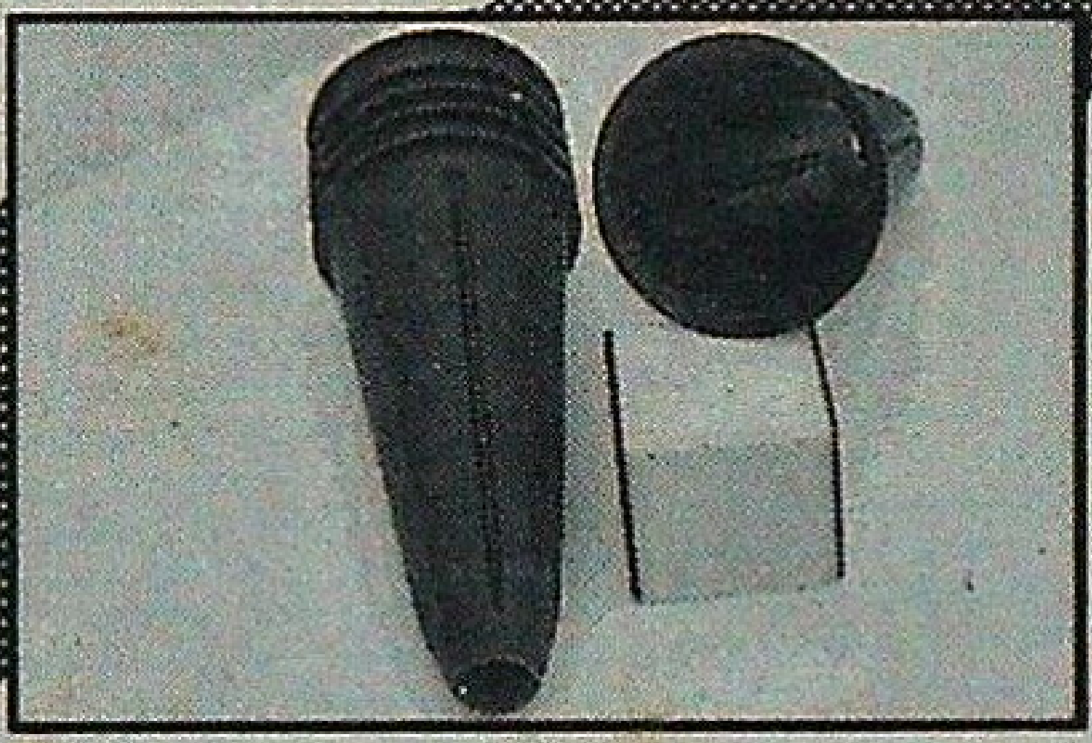

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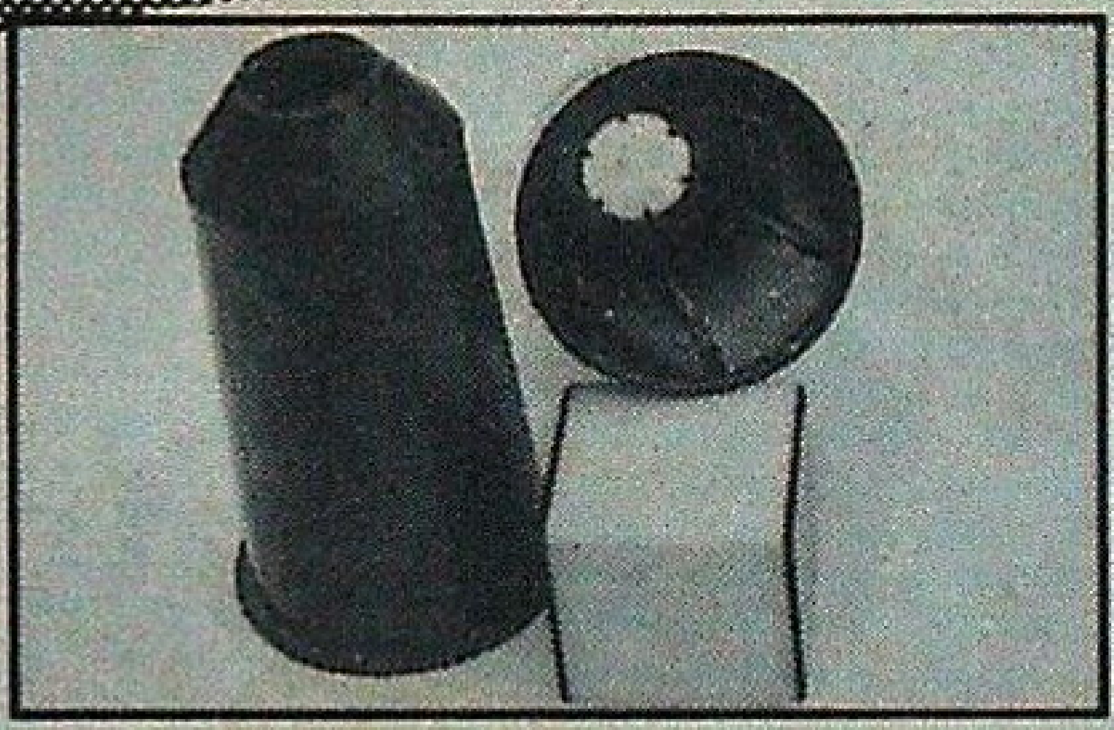

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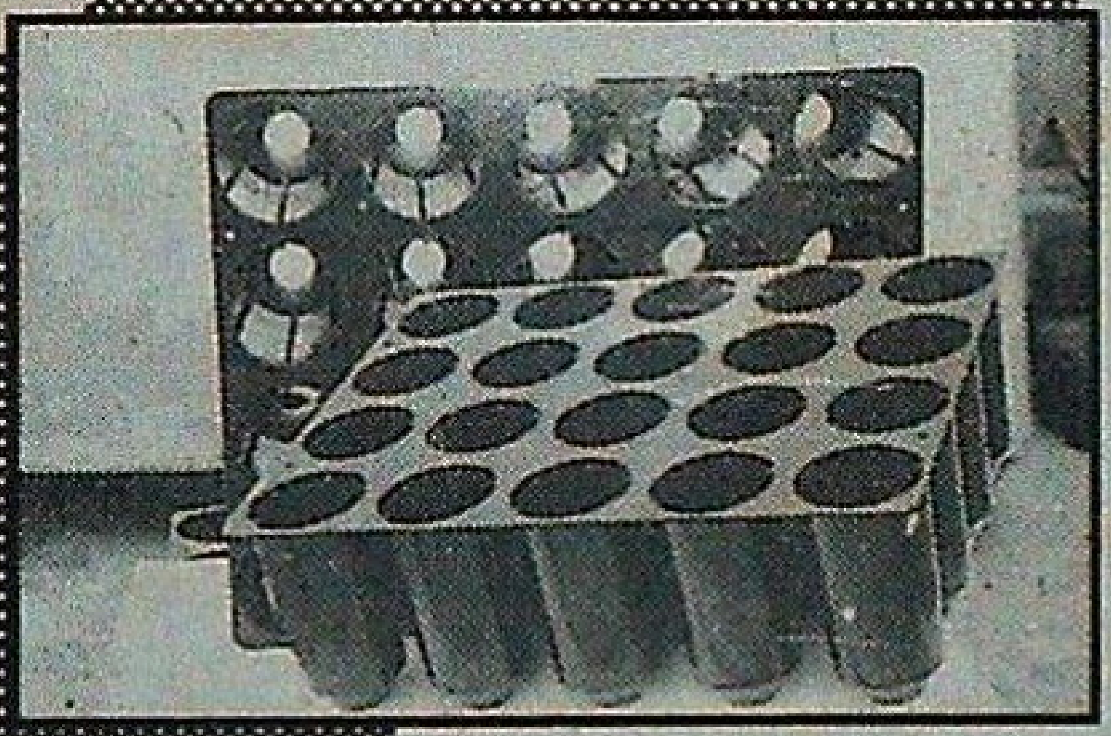
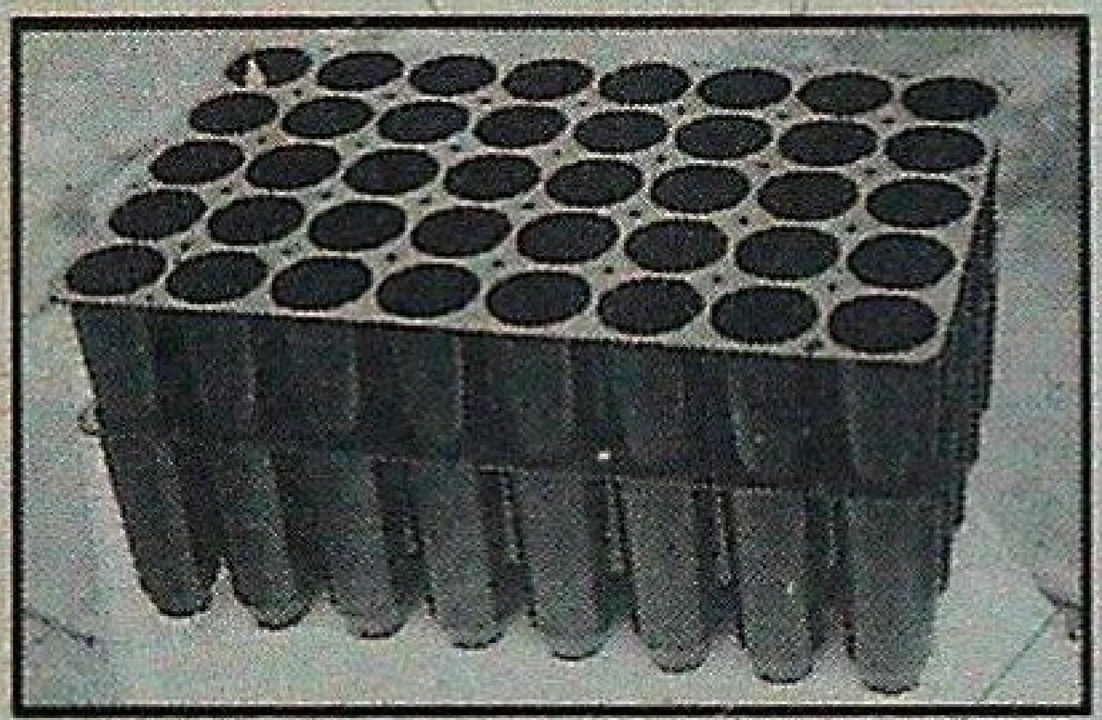
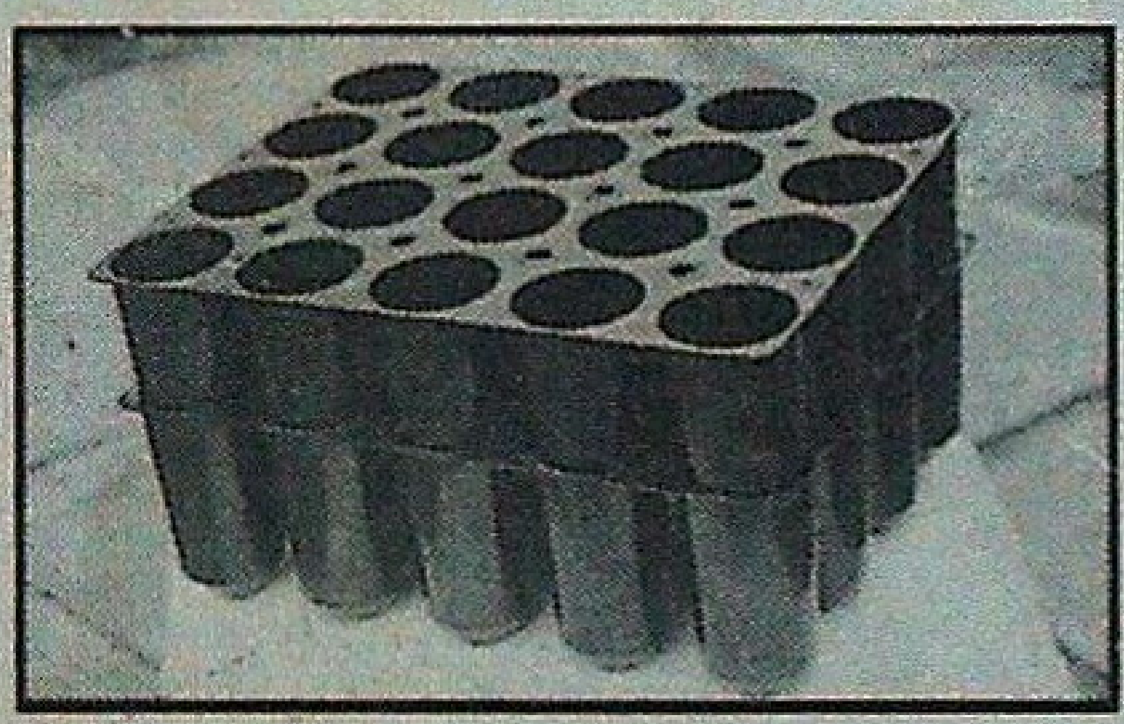
Single Root Trainer
Volume - 150 c.c.



Compo - 150
Block of 20 cells
Volume - 150 C.C.



Compo-110 (VA)
Block of 40 Cells with
Vertical Aeration & Internesting.
Volume - 110 C.C.



Compo -150 (VA)
Block of 20 cells with Verticle
Aeration & Internesting.
Volume - 150 c.c.

ALL THE ABOVE ROOT TRAINERS HAVE 6 RIDGES

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THE
INDIAN FORESTER

VOLUME 125 SEPTEMBER 1999 NO. 9

1524

**Biodiversity is the totality of genes,
species, ecosystems and
ecological processes in the region.
Biodiversity consists of four elements :
(1) Genetic diversity,
(2) Species diversity,
(3) Eco-systems diversity, and
(4) Process Diversity.**

Published by Rajesh, I.F.S. (Asstt. Silviculturist) from Forest Research Institute, Dehra Dun on behalf of the Board of Management, Indian Forester, Dehra Dun. Printed by S.K. Arora at Print World, 29-Rajpur Road, Dehra Dun. Hony. Editor : G.S. Rawat, I.F.S. (Head, Silviculture Research, Forest Research Institute, Dehra Dun).

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